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AACE BULLETIN

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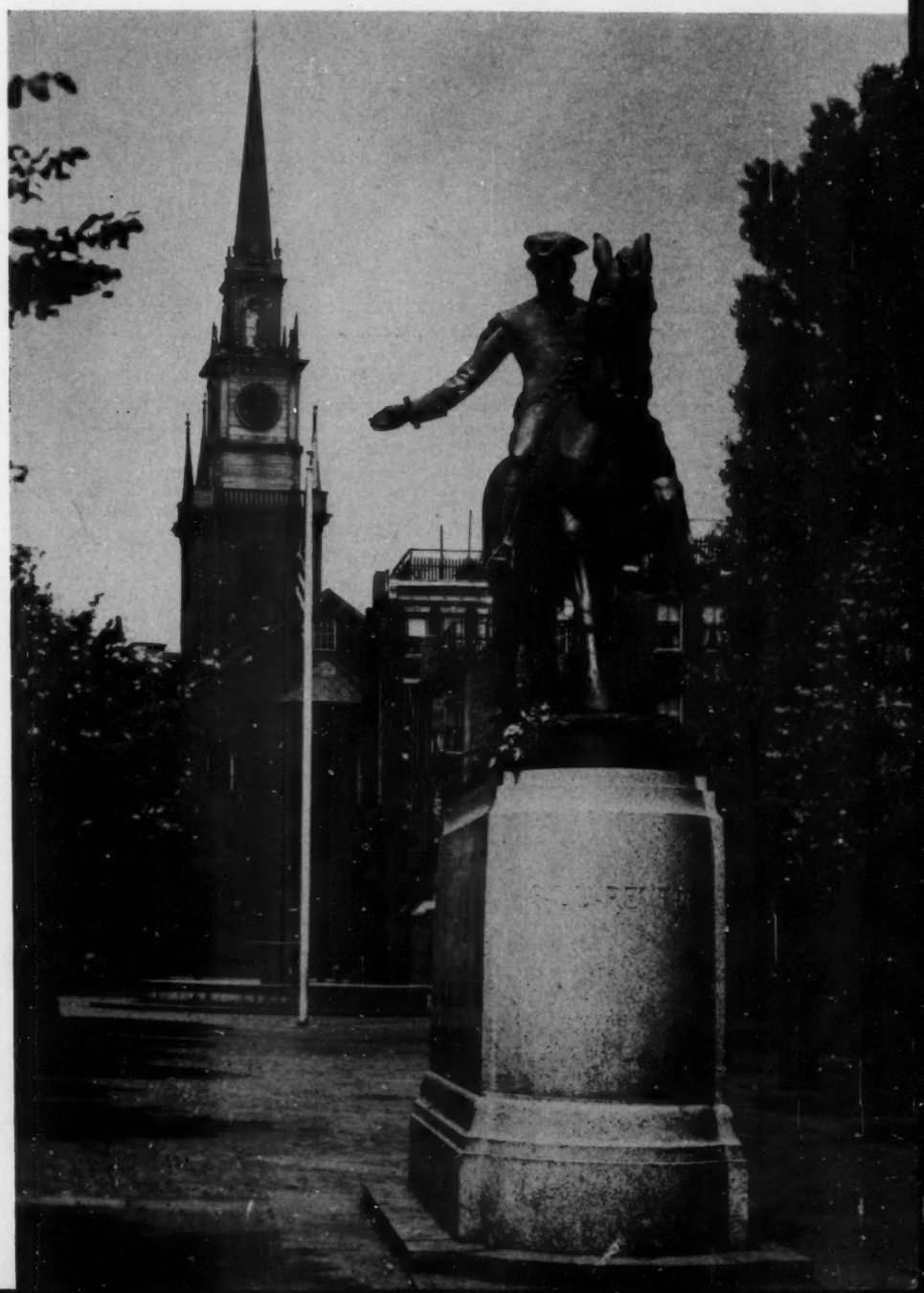

AACE BULLETIN

Vol. 2, No. 4 — Vol. 3, No. 1 December, 1960 — March, 1961

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Notes from the Editor

The program for the Fifth Annual Meeting is being finalized. Boston is putting out the welcome mat. Everyone who is anyone has circled June 21-23, 1961 on his calendar and is planning to attend. Hope you will be there!

At a recent Board of Directors meeting action was taken to improve the regularity of issuing the *AACE Bulletin*. We appreciate your patience during these early years, while our growing pains necessitate the wearing of many hats by a few people. It is our avowed objective "To provide forums and *media* through which experiences with the principles and techniques of cost engineering may be reported, discused and *published* for the common good". You can be sure that everything is being done to meet this objective and be of continuing and greater service to our members.

As President Hirt notes in his column, "in every committee activity, there is much to be done, and opportunities exist for each member to participate." Therefore, why not look at the list of committee chairmen in this issue, contact the one in whose area you are interested and I am sure the result will be a mutually enriching one.

See you in Boston!

COVER

The famous steeple of Boston's "Old North Church" towers above the lifelike statue of the famous American patriot, Paul Revere. It was here on April 18, 1775, that "The signal lanterns of Paul Revere warned the country of the march of the British troops to Lexington and Concord."

The "Old North Church" is a favorite stopping place along Boston's famous Freedom Trail which takes visitors to Boston on a systematic walking tour of the city's many historic shrines.

A fine technical meeting, the many other attractions, plus these historic sights, will make the 5th Annual Meeting of the AACE an outstanding event you will not want to miss.

Message from the President

Charles R. Hirt
The Procter & Gamble Co.
President of AACE

With mixed emotions of humility and gratification, I want to express my appreciation for the confidence you have shown in electing me as your President. Following in the footsteps of my predecessors, and facing the challenges of this youthful and robust organization, I feel deeply humble; to be in the position to work closely with all the very good friends that I have made since that hot day in June, 1956, at the University of New Hampshire, makes me very happy and thankful.

I am sure that the other Officers and Directors feel equally proud, and I know that whatever is required of them for the good of the Association, will be forthcoming. For my part, I shall try to serve you to the best of my ability.

We all face many problems in such a young organization, and we all must be willing to contribute some effort to further our aims and objectives. The future is by no means certain. The solutions to our problems are by no means clear. All of us, working together — the Board of Directors, the Regional Sections, the individual members — must make certain that our actions are directed to the fulfillment of our objectives, and to the sound long range growth and development of the profession of Cost Engineering.

To those members who have contributed so generously of their time and talents during the past five years, the Association owes a great deal of thanks. We will never be able to adequately demonstrate our appreciation, but we are all richer because of their contributions.

To those members who have held back from participating actively in the Association, we want to invite your help. Whatever one possesses, becomes of double value, when you have the opportunity of sharing it with others.

1961 will be a critical year for us; we are growing rapidly, and with this growth comes added benefits — and added responsibilities. We all profit from the added benefits — we all must be willing to share in the added responsibilities.

As we grow, the need for more effective communication and control becomes painfully apparent. The cost of providing adequate administration of the Association, and the desirable services to the members, continues to mount. The opportunities for contributing to our new technology are almost limitless; the desire to learn of others' experiences is equally unlimited. Our obligations as a professional association need serious attention. Progress in providing technical standards or guides must be accelerated.

In almost every corner of our organization, . . . in every committee activity, there is much to be done, and opportunities exist for each member to participate. Those who look up, not down, when the opportunity for service and help presents itself, will get more out of the association than those who merely complain that the association is doing nothing for them. One who does nothing to help solve our problems, actually helps to worsen them.

We can be justly proud of the progress made in the past five years; now is the time to cash in on some of our dividends earned by those hard working, loyal members who have contributed so much. We should try to consolidate our gains, and broaden our exchange of information and experiences. Greater emphasis is necessary on securing technical articles for the *Bulletin*. Our journal can become an increasingly important source of cost engineering information for everyone, but all of us must cooperate in volunteering our contributions for publication. At the February Board Meeting, action was taken to improve the conditions causing some of our current problems with the *Bulletin*, and to assure that the publication maintains a strict schedule. Each member should now be getting his copy on time, at regular quarterly intervals. You will be interested to know that a new membership directory will be publised as a part of the next issue, and annually thereafter in the June issue.

To meet the rising costs of the increased services we hope and need to provide, we must expand our membership to include all those who can profit from participation in the Association. The Membership Committee alone cannot reach enough people with the message; we must all be alert to the opportunities to explain the advantages of membership to all prospects.

(Continued on page 26)

In Passing

Dr. Bernard J. Gaffney
Wood Conversion Company
Past-President of AACE

As one TV newsman is apt to say, "What kind of day has today been?" — what kind of AACE activity is worthy of news?

Well, guess there is quite a bit and a major portion seems palatable. However, business never seems to go on without some problems, some of which will be taken up before closing.

By now you all know the election results and it seems certain that you have selected a fine executive staff to carry us through next year. Mr. Charles Hirt, the incoming president, was the man who initially stirred my imagination about the potential of the AACE, and my initial duty was reporting to him as head of the Planning Committee. The incoming vice president, Mr. Bill Clark, is certainly a man having forward vision in AACE affairs and has done a most creditable job in his own regional section. I know that you will give them your wholehearted cooperation in the coming year and that a number of our members will be given the opportunity to serve in various capacities.

On the evening of November 15 we had an abridged form of meeting of the Board of Directors. We were just shy of enough board members to make a quorum to pass on a number of matters but did much preparatory work for the next board meeting and came to an understanding on some pressing AACE problems.

Mr. Wes Dodge, Chairman of the Regional Sections Committee, was in attendance and gave us a rundown on the status of new sections. It appears that for our next meeting the formal board action will be asked in accepting the following sections — Los Angeles, Niagara Frontier, the British Group and Montreal. This certainly is a very creditable accomplishmennt this year and much of the credit is to go to Mr. Dodge who has certainly done a very splendid job.

The matter of EJC application was discussed and although we do not have any formal report from Washington, it does appear that we shall be successful in our efforts.

One of the matters discussed was the name for our parent organization. It appears that calling it a national association will not now do as we have members and sections in countries other than the U. S. A. and that we are international in operation. It appeared that the term, parent association, would perhaps be most descriptive and appropriate.

One of the invited guests to our board meeting was Mr. H. J. DeLamater who gave us a nice rundown on the preparatory work that is going on in the Boston section for our meeting there next June. In retrospect the Houston meeting was very successful both financially and in promoting AACE affairs. If the picture painted by Mr. DeLamater is by any measure indicative, the Boston meeting will be equally, if not more, successful.

Another topic — that of publication of the *Bulletin* was reviewed. The parent association has certainly grown to the point where we now visualize a more businesslike setup in the editing and publication of our *Bulletin*. Our executive secretary has been carrying many hats, and it is quite likely that at our next board meeting he will be relieved of certain duties associated with the publication of the *Bulletin*. He has done a most outstanding job of getting this publication out under very trying circumstances. Under the new setup envisioned, he will have more time to devote to those duties which would properly be those of an executive secretary of our association.

Our cost index manual came in for quite a discussion and very critical review. It is judged that the present issue of the cost index manual falls far short of expectations. It does offer an introduction to a number of cost indexes but it is not at all inclusive. The manual does not yet fill a primary need of interpretation of indexes explaining the various uses to which they may and may not be put and does not give a critical analysis of the cost index subject. Plans are now underway to revivify the cost index committee and to define objectives and to get some very positive action and AACE development work done on this subject. It is anticipated that reports

(Continued on page 27)

Comparing Costs of Nuclear Fossil Power

J. G. HOYT and C. F. KAHLER, General Electric Co., San Jose, California

With a relatively constant increase in service demand and a supply of low-cost debt capital, electric utilities have historically been able to raise share earnings and dividends, minimizing cost increases due to inflation.

Through research efforts of electric manufacturers, the electric utilities have been able to buy improved generating equipment to maintain profits at acceptable levels. But the industry may be facing more serious problems in the future because advances in generating efficiency may not be enough to offset continued inflation in production costs.

Limited, in general, by regulatory agencies, earnings of utilities are related to the rate base and rate of return. This doesn't mean that a utility is guaranteed or assured certain earnings. The amount of return allowed is a permissive figure, an upper limit. Whether or not permissive earnings are realized depends on the operating results of the utility.

We shall examine here the long-term profitability of nuclear plants by considering the probable lower operating costs (variable costs) of nuclear plants in relation to fossil plants. The methods used are adapted from practices described by the Bureau of Power of the Federal Power Commission in its **Technical Memorandum No. 1**, Nov. 1955, with supplements, for use in estimating electric power costs and values.

Unit generation cost (dollars/kwh.) include fixed costs and variable costs. For a realistic comparison, it's necessary to allocate to fixed costs a certain proportion of what are usually considered variable costs.

Fixed costs are: fixed capital charges; fixed component of fuel charges; part of production expenses, other than fuel; administrative and general expenses. The remaining costs depend upon the amount of energy generated, and they constitute the incremental cost of energy.

Consider Fixed Charges

Varying over a wide range, fixed charges depend on many factors. The utility can control some factors, such as financial structure, but others depend on location, state of the money markets at time of financing, whether station will be used for base load or peak demand, etc. Fixed charges, nevertheless, include only a few components — cost of money to the utility, depreciation, interim replacements, insurance and taxes.

A balanced financial structure for electric utilities is often considered to be 50% in bonds, 20% in preferred stock and 30% in common stock. Although this ratio is not true for all utilities, it is typical of many.

The cost of long-term borrowing as of the beginning of 1960 reflected tighter money conditions than had existed for perhaps a generation. Moreover, the outlook is for high interest rates as long as there is a threat of inflation. Under the assumed financial structure, Table I shows cost of money to a utility. Lower than the extreme highs of early 1960, the average cost could rise by 1-3% if higher interest rates return.

Note, from Table I, that the utility should include in its rate of return a minimum of 5.95% to compensate its bond holders and preferred stock-holders, and to provide a return on common stock sufficient to attract new capital.

Our proposal allocates depreciation over a 35-year service life, both for fossil and nuclear plants. Based on continuing studies of Classes A and B electric utilities, the Bureau of Power recommends a 35-year service life for fossil stations. And General Electric Co. generally specifies a 40-year useful life for reactor pressure vessels, the component subject to highest radiation levels in a nuclear plant.

In power economic and evaluation studies, the sinking fund method of depreciation is commonly used. This method considers the fact that resources accumulated through operation

Table I — Cost of Money

Source of Capital	Percent of Total Capital Structure	Required Rate	Weighted Cost of Money
Bonds	50	4.5%	2.25%
Preferred stock	20	5.0	1.00
Common stock	30	9.0	2.70
Total	100		5.95

contribute to earning capacity just as any other capital. The equation for the method is:

$$N = Sr/[(1 + r)n - 1]$$

where N is sinking fund charge for accounting period, S is cost less net salvage value, r is rate of return and n is anticipated service life in accounting periods.

The investment will be amortized in 35 years by 0.9% of total plant investment compounded annually at 5.95%. But in addition to ordinary depreciation, provision must be made for those components that don't last 35 years and require interim replacement, e.g., boiler tubes and heat-exchanger tubes. Their cost is computed each year on a fixed basis of 0.35% of total plant investment.

Insurance and Taxes

Insurance covers cost of fire, storm, vandalism, boiler and machinery, public liability, property damage and other operating hazards. It's assumed here to be 0.25% of total plant investment for both nuclear and fossil plants. Nuclear insurance, as such, is included separately later.

Federal, state and local taxes make up the final fixed-charges component. Profits before Federal income taxes may be split, for all practical purposes, into two parts: 52% goes to Federal income taxes, 48% goes to increase the equity of preferred and common stock holders. If the return to the two classes of stockholders is 3.7%, Federal income tax will amount to 4.01%.

Miscellaneous Federal taxes for either type of plant are computed at 0.1% of total plant investment.

In a study of taxes paid during 1954 by some 150 privately owned utilities, the Bureau of Power found that state and local taxes were 2.28% of total plant investment. Since it's likely that this figure is higher now, we propose to use 2.44%.

Table II shows how these components total to the annual fixed charges for a privately owned steam-electric utility for the assumed conditions. Actual costs may vary from 11% to 18%.

Other Components of Fixed Costs

The fixed component of fuel charges is that part of the total fuel, burned over the life of the plant, which is required to operate the plant during no-load periods, plus fuel equivalent to spinning reserve requirements during load-carrying periods. Fuel in excess of such requirements represents the variable, or incremental, component.

The fixed fuel component of fossil fuels was estimated by the Bureau of Power as follows:

Type of Plant	% of total fuel consumed
Coal-burning plant	10%
Oil-burning plant	9
Gas-burning plant	8

For nuclear plants, we estimate that not more than 8% of such items as fabrication cost, uranium depletion, recovery costs and plutonium credit, plus 80% of the lease charged, should be included as the fixed fuel component.

Related, in part, to use of the plant, a fixed component of operating and maintenance costs must be determined. The Bureau of Power uses 65% of total operating and maintenance expenses as the average fixed component of operating and maintenance costs for Class A and B utilities.

The fixed component may be even higher for nuclear plants, particularly if the nuclear plant has a higher capacity factor than the fossil plant. In the analysis that follows, 65% is used for both types of plant.

General and administrative expenses are considered to be fixed expenses. The FPC memorandum, cited above, allocates 20% of the fixed operation and maintenance costs, exclusive of fuel costs, to the generation plant account as general and administrative expenses. We propose the same procedure for nuclear plants.

Plant Capacity Figure

In comparing the generating costs of two plants, it's necessary to consider whether they will both have the same utilization throughout their service lives.

During the early years of its life, a plant is operated as a base-load plant with a high capacity

Table II — Total Annual Fixed Charges

Item	Percent of Total Plant Investment
Cost of money	5.95
Depreciation, 5.95% sinking fund	0.90
Interim replacements	0.35
Insurance	0.25
Taxes	6.55
Federal income, 4.01%	
Federal miscellaneous, 0.10%	
State and local, 2.44%	
Total annual fixed charges	14.00

factor. Plants are put on-line in order of their full-load fuel costs. As new plants with lower incremental fuel costs are added to the system, the old plant is gradually displaced from the base-load position. Its capacity factor declines until it is finally retired from service.

The plant capacity factor used for steam-electric plants by the Bureau of Power in its comparative studies is 51.4% over the life of the plant. Will fossil plants going into service today have capacity factors as low as this over their entire life? The answer is a matter of opinion, but it can be looked at from two different aspects.

First, there are many reasons for believing that plant heat rates for fossil plants are approaching economic limits. The attempt to lower heat rates by higher pressure and temperature, more reheat cycles, etc., results in greater capital charges, reducing much of the fuel cost gain.

The outlook for continued low fuel prices, too, is not an inducement to reduce heat rates. Hence, without nuclear power with its potentially low fuel costs, it might well be that new fossil plants would have a considerably higher capacity factor over their service life than plants going on-line in the past.

Second, the key to plant use, relative to other plants on the system, is incremental operating cost. In scheduling hour-by-hour operation, incremental costs are conventionally regarded as those added costs of increasing output above the demand at which the plant is operating at any given moment.

In this paper, incremental costs are those added costs of increasing output from zero output power — costs that vary with energy production, as distinguished from the fixed costs previously described.

But regardless of the definition used, we expect that nuclear plants will show lower incremental costs than fossil plants. It is, therefore, reasonable to expect that wherever a nuclear plant is found to be competitive, it will displace the fossil plant from the base-load position of the utility's demand curve. On this basis, competitive nuclear power will cause even newer fossil plants to have no better lifetime capacity factors than those going into service some years ago.

What is the outlook for the capacity factor of a nuclear plant over its service life? The nuclear submarine **Seawolf** operated for over two years without opening the vessel that contained the nuclear core. On one occasion, the **Seawolf** operated submerged for 60 days. And the Vallecitos, Calif., boiling water reactor, though designed as a developmental plant by GE, has operated several months with an equivalent capacity factor of more than 90%.

Furthermore, nuclear cores today are still in a declining cost stage. Fuel costs of a given nuclear plant show promise of continued reduction as nuclear cores are improved and fabrication costs reduced. Thus, any particular nuclear plant may show lower fuel costs in the decades following initial operation.

Once a fossil plant is put online, however, its incremental fuel costs are relatively fixed. They may fluctuate only as fuel prices go up or down. It seems likely, therefore, that a nuclear plant can maintain its base-load position in an interconnected system for many years longer than a fossil plant.

Table III — Costs of Selected New England Fossil Plants

Initial Operating Year	Power Mw.	Plant Cost $/Kw.	Fuel Cost Mills/ Million Btu.	Fuel Cost Mills/ Kwh.	Operation and Maintenance (less fuel)
1954[1]	166	189	38.02	4.26	1.03
1957[1]	75	258	36.31	3.65	0.94
1957[2]	88	219	39.60	4.30	0.62
1952[3]	320	176	41.50	4.07	0.72
1949[4]	172	189	38.30	4.39	1.31

Notes: (1) Connecticut; (2) Maine; (3) Massachusetts; (4) New Hampshire.

A Fossil Plant for Comparison

When considering fossil fuel costs, it's unneccessary to consider an "average" cost area. If nuclear power is competitive in an area of high fossil fuel cost, a plant can be sold there. If nuclear power is noncompetitive, a developmental plant may be sold occasionally, but continuing sales will depend on meeting fossil power cost competition. That, of course, will first occur in such high power areas as California and the New England states.

Table III shows recent New England plant costs in dollar/kw. of name-plate capacity, and fuel costs per million Btu. and per kwh. for the major type of fuel used. Source of the data is FPC **Steam-Electric Plant, Construction Cost and Annual Production Expenses for 1958.**

Table IV — Generation Costs for Nuclear Plants and New England Fossil Plant

Item	Nuclear (High) Total	Nuclear (High) Fixed	Nuclear (High) Variable	Nuclear (Low) Total	Nuclear (Low) Fixed	Nuclear (Low) Variable	Fossil Plant Total	Fossil Plant Fixed	Fossil Plant Variable
Capital charges*	5.49	5.49	0	4.00	4.00	0	5.60	5.60	0
Fuel							3.60	0.36	3.24
Uranium lease charge	0.36	0.29	0.07	0.30	0.24	0.06			
Other fuel charge	2.74	0.20	2.54	2.20	0.18	2.02			
Operation and maintenance	0.80	0.52	0.28	0.70	0.46	0 24	0.70	0.46	0.24
General and administrative	0.16	0.16	0	0.14	0.14	0	0.14	0.14	0
Nuclear insurance	0.20	0.20	0	0.20	0.20	0			
Total	9.75	6.86	2.89	7.54	5.22	2.32	10.04	6.56	3.48

* Capital charges for nuclear plants are based on 80% lifetime capacity factor; for fossil plant, on 14% fixed charges, 51.4% capacity factor.

Escalating these costs to today's prices, it's not difficult to believe that 1960 capital costs for a 200-mw. fossil plant in some areas of New England would be $180/kw., with operating costs (Table IV) based on a lifetime capacity factor of 51.4%.

A Nuclear Plant for Comparison

A General Electric Company program, "Operation Sunrise," is planned to attain competitive nuclear power through design, development and construction of a series of plants, each plant profiting from experience gained from its forerunner. First plant of the series, for the Pacific Gas and Electric Co., is 50,000-kw. natural-circulation boiling water reactor to be constructed at Eureka, Calif. The second plant, a 50,000-kw. high-power-density plant, will be erected in Michigan for Consumers Power Co.

From experience gained in design of these two plants, and from the Dresden Plant at Chicago and SENN plant in Italy, it's believed that a 200-mw. dual-cycle boiling water reactor can soon be offered anywhere in the United States or Europe for less than $250/kw. This cost, of course, depends on successful outcome of research and development work on pressure suppression, internal steam separation, and higher power densities in the core. It is a cost, nevertheless, that is well in sight.

Assuming that an additional cost of $25/kw. will be incurred by the utility for land and land rights, interest during construction, working capital and startup costs, the total capital cost of the plant would amount to $275/kw. Plants offered in a later stage of "Sunrise" should bring total costs to a lower level — in a range of from $175/kw. to $200/kw.

Later plants may also be expected to have lower fuel and other costs than the earlier plants. Hence, a range of costs for nuclear plants might appear as shown in Table IV, using a lifetime capacity factor of 80%.

Comparative Costs of Plants

The comparison is incomplete, however, because incremental costs determine a plant's position in the utility load curve. And for nuclear plant costs, the fuel requires a more detailed treatment than for fossil plants. Of the fuel lease charge, 80% is a fixed cost, and only 8% of fabrication cost, uranium depletion, recovery costs and plutonium credit are fixed costs. The breakdown of fixed and incremental costs for both fossil and nuclear plants is shown in Table IV.

There is enough difference between the fossil and nuclear variable cost to suggest that a high rate of utilization of the nuclear plants is justified, and that they would replace the fossil plant in the base-load position of the utility demand curve.

Nuclear plants will soon become economically competitive with fossil plants in high-cost fuel areas. Once a competitive nuclear plant has been installed with lower incremental costs than those of the existing fossil plant, it will be used to supply the utility base load. This high rate of utilization results in low average kilowatt-hour costs.

Continued improvement in nuclear cores may be expected to take place over the years, resulting in further reduction in costs. Such cost reductions assure that a nuclear plant will be used in the base-load position of a utility demand curve for a greater number of years than a fossil plant. Nuclear plants may be expected, therefore, to have higher lifetime capacity factors than fossil plants.

Evaluation of Estimating Methods

THOMAS J. ROCHE, Cook County Highway Dept.

The training of an engineer, based as it is on physical laws, tends to make him conscious of "standards" or "universals." This attitude is essential while he is working in any field governed by physical laws. In the field of design he is also encouraged to develop his creative ability unhampered by any restrictions beyond the physical requirements of his design problem.

He will have gained this engineering knowledge in any field of his choice save one — cost engineering. Whatever knowledge he must have in this cost field he merely "acquires." That acquired knowledge is not only foreign to whatever engineering he has learned previously, but is contrary to it in its fundamentals. The engineer who finds himself adrift in the unfamiliar seas of economics and finance may have to jettison much of this ballast of engineering stability when he rides these tides and currents.

The price of a thing is whatever some one will pay for it at any particular time — no more or no less. The laws of economics operate on daily human decisions, infinite in number, which create the currents and the tides. When the engineer grasps that truth, he is on his way to becoming a cost engineer. When he gives up the notion that somewhere, somehow, the particular costs he seeks are neatly labelled and tabled like chemical formulae or structural steel and trigonometry tables, and instead, strikes out on his own, he has actually become what his title implies — a cost engineer.

In his development, he will probably pass through various stages. In his first assignments he may grasp in desperation at any cost figures that remotely fit the project at hand, especially if those figures are in print. At this stage he is still looking for those universal prices that exist someplace if only he can locate them.

The cost engineer who takes his costs where he finds them, without questioning the controlling factors that determined them, has no knowledge of his margin of inaccuracy, and his cost estimate is therefore valueless. The controlling factors are the original plans and specifications, the age of the data, local labor costs and production rates, availability of materials, bidding competition and so on for a dozen more factors. It would probably take longer to check these factors than to compute independent costs. Unless the cost engineer is looking for very approximate costs he should avoid the use of such data.

If he bends and twists the order-of-magnitude graphs completely out of shape to fit his needs, he likewise ends up with valueless cost estimates. While such graphs have their definite purpose in obtaining approximate cost estimates, these graphs should be definitely limited to such approximate estimates.

In working with these order-of-magnitude graphs, the cost engineer will at first have a tendency to assume they are made to order for his particular project. The fact that they usually reflect nation-wide conditions and that they must be fitted to local conditions is often overlooked. Rural costs should normally be less than the graph values and urban costs should be more.

In urban localities, where the largest amount of construction is usually done, there are cost influences which might be called metropolitan factors. Examples are distributors' costs, haulage and production delays due to congested traffic, higher labor, material and equipment costs.

At the next stage of development the cost engineer will probably hit upon unit bid prices from his own or similar projects as the solution of his problem. It seems that the logical thing to do is to average the unit bid prices for one project and be thereby prepared for the next project.

A refinement of such a method will be the passing from simple average bid prices to weighted average bid prices, and later on, an "analysis" of the bid prices by electronic computer. But at this stage the engineer should recall that no matter how impressively the lights flash, the buzzers buzz and the electrons dance, what comes out of the machine is precisely as accurate as what goes into it.

What goes into it is often inaccurate for a dozen reasons. When contract awards are made on the basis of total bids, which is the usual way, bidders can and usually do, vary individual unit prices to suit their fancy and convenience. The absurdity of the entire proceeding however, can be centered in this: the cost engineer goes to the bidders for the data to check their own bids. The bids might just as well be accepted at their face value, without control, at a saving in time and money.

Costs based on any data previously discussed may produce estimates, but not engineers' estimates. The last half of the title

"cost engineer" should be just as important as the first half.

It is assumed that the cost engineer has sufficient design and construction experience to understand the problems involved in building a given project.

His design experience will enable him to understand the plans and specifications and his construction experience will help him to visualize the actual scheduling of operations and their relative difficulty.

It is likewise assumed that he has available the labor rates, both pay and production, from several of his own projects.

With such field report data, it will be possible to establish usable average production rates for the various units of construction or payment items. These are recurring items based on constant units such as ton, cubic yard, pound or lineal foot.

Starting with these manhour per unit figures, the cost engineer can then develop his own cost estimating method, adaptable and fast, yet accurate enough for control purposes. If ratios are used in place of extended computations, much time can be saved and flexibility maintained.

There are in any construction project just three elements — labor, material and service. The latter includes all costs not obviously chargeable to labor or material. In recurring projects, it is usually possible to equate all labor rates on a project ratio-wise to one rate — for instance, common labor.

Service costs include equipment costs, general and project overhead and profit. In recurring projects, it will be found that the total of such items usually bears a constant ratio to the total labor costs for each particular type of project.

The service cost ratio can then be combined with the average labor rate to obtain a single labor-service factor applicable to each type of project, and for a given locality, that will be usable for a year or more.

By multiplying the man-hours per unit from the construction reports by the common labor rate and this labor-service factor, the labor and service cost of the unit item is quickly obtained. The material quotation per unit is then added to get the total unit cost.

Although the man-hours per unit and the service factor for each type of project may take considerable time to compute for the first projects, they change slowly and may need only annual renewal.

Material costs are the most difficult to pinpoint and the cost engineer should be reminded again that the price of a thing is what someone will pay for it. It is in this area that the laws of supply and demand get full play. No further contingency allowance is usually needed in any cost estimate than the one that is automatically contained in the list price material quotations. He who comes with definite order in hand can expect a lower price than the one who seeks merely a control quotation.

By evaluating his own estimating method on the basis of substantiated accuracy, which is the engineering way, the cost engineer will be better prepared to evaluate the accuracy and validity of his project costs.

Provisional Definitions, Selected Terms

Submitted by Definitions Subcommittee, July 22, 1960

R. A. Mohr, Spencer Chemical Co., Kansas City, Missouri
H. C. Thorne, Jr., Amoco Chemicals Corp., Chicago, Illinois
A. G. Bates, Atlas Powder Co., Wilmington, Delaware
T. E. Drisko, Jr., Dow Chemical Co., Pittsburg, California

The AACE Profitability Committee, under the chairmanship of Al Bates of Atlas Powder Company, is considering the development of a Profitability Manual to be issued in sections. It is hoped that a set of definitions can be issued to the membership at the 1961 Boston meeting as one of the first sections of this manual. The attached "Provisional Definitions" have been prepared by Tom Drisko, Bob Mohr and Henry Thorne of the Definitions Sub-Committee with this purpose in mind. Comments received to date have been most valuable and incorporated where possible in the attached draft. **It is submitted to the entire membership now to obtain as many suggestions and comments possible before final release. Comments could concern ommissions, improvements or corrections to the listed definitions or possibly unnecessary terms. They should be mailed to:**

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General Terms

Accounts Payable — the value of goods and services available for use in the plant on which payment has not yet been made. See also taxes payable.

Accounts Receivable — the value of goods shipped or services rendered to a customer on which payment has not yet been received.

Administrative Expense — the overhead cost due to general direction of the company, above the plant manager level. Generally includes top management salaries, legal, central purchasing, traffic, accounting, and other staff functions.

Book Value (Net) — Current investment value on the books, calculated as original value less depreciation accruals. Net asset value for accounting use.

Capital Budgeting — A systematic procedure for classifying, evaluating and ranking proposed capital expenditures for the purpose of comparison and selection, combined with the analysis of the financing requirements.

Capital, Cost of — the weighted average of (1) the after tax cost of long term debt, (2) the yield on any outstanding preferred stock, and (3) the cost of common equity capital.

Capital, Fixed — the total original value of physical facilities which are not carried as a current expense on the books of account and for which depreciation is allowed by the Federal Government. It includes plant equipment, building, furniture and fixtures, transportation equipment used directly in the production of a product or service. It includes all costs incident to getting the property in place and in operating condition, including legal costs, purchased patents, and paid up licenses. Land, which is not depreciable, is often included. Characteristically cannot be converted readily into cash.

Capital, Modernization (Sustaining Capital) — the fixed capital requirement to maintain the competitive position of a project throughout its commercial life by improving product quality, related services, safety, or economy. Capital for those improvements which generate savings is only partially modernization capital. The excluded portion is the fixed capital supported at project profitability by the savings generated.

Capital, Working — the funds in addition to fixed capital and land investment which a company must contribute to the project (excluding startup expense, to get the project started and meet subsequent obligations as they come due. Includes cash, receivables, payables, and inventory. Characteristically, these assets can be converted readily into cash. Working capital is normally assumed recovered at the end of the project without loss.

Cash Flow — the net flow of dollars into or out of the proposed project. The net sum in any time period of all cash funds for the project, less all outlay of expense and investment. Also called cash proceeds or cash generated.

Cash Return — the difference between revenues and all cash expenses, including taxes. The sum of net profit after tax and the depreciation deduction used in calculating net profit.

Cost Index (Price Index) — a number which relates the cost of an item at a specific time to the corresponding cost at some arbitrarily specified time in the past.

Depletion — The allocation of the value of the quantity of natural resources extracted from a deposit (applying to resources not replacable by human beings). A non-cash expense, but an allowed tax deduction. See depreciation.

Depreciation — the allocation of the cost fixed capital assets less salvage (if any), over the estimated useful life of the unit, in a systematic and rational manner. A non-cash expense. For the cash flow tabulations used in various profitability measures, depreciation is important only as an allowed deduction from income taxes.

Development Costs — those costs specific to a project, either capital or expense items, which occur prior to commercial sales. Major cost areas include process, product, and market research and development.

Fixed Costs — those costs independent of short term variations in output of the system under consideration. Includes such costs as labor, maintenance, technical service and labortory expense, taxes and insurance, plant overhead, and administrative, selling, and research expense. For the purpose of cash flow calculations, depreciation is excluded (except in income tax calculations).

Incremental Costs (Revenues) — the cost and revenue differences between two alternate courses of action. These should be based on changes which can actually be foreseen as occurring rather than having accounting conventions to approximate overheads, etc. However, should reflect differences in the use of existing personnel or facilities as well as the actual forecast changes in cash flow. Costs refer both to investment and annual operating costs.

Interest, Compound — the rate earned by money expressed as a constant percentage of the unpaid balance at the end of the previous accounting period. This period can

be yearly, quarterly, monthly or instantaneous.

Inventory — the value of raw materials, products in process, and finished products required for plant operation. Also, other supplies, i.e., for maintenance, catalyst, chemicals, spare parts.

Leverage (Trading on Equity) — the use of borrowed funds or preferred stock in the intent of employing these "senior" funds at a rate of return higher than their cost in order to increase the return upon the investment of the residual owners.

Manufacturing Cost — the total operating costs chargeable to manufacture of a given product. Includes raw material and processing costs, technical service and laboratory expense, labor, utilities, catalysts and chemicals, packages, maintenance, plant overhead, insurance, and property taxes. Depreciation is sometimes included and sometimes excluded. Normally excludes administration, selling and research expense. See variable costs, fixed costs.

Maximum-Out-of-Pocket Cash — the highest year-end negative cash balance during project life.

Net Profit — the residual earnings after certain non-cash expenses, e.g. depreciation.

Opportunity Cost — the profits from alternate ventures that are forgone by using limited facilities for a particular purpose.

Optimum Plant Size — the plant capacity which represents the best balance between the economies of size and the cost of carrying excess capacity during the initial years of sales

Plant Overhead (Factory Expense) — those costs in a plant which are not directly attributable to any one product or processing unit and therefore can be allocated on some arbitrary basis believed to be equitable. Includes plant management salaries, payroll department, local purchasing and accounting.

Project Life (Economic Life) — total years of operation for any facility. Sometimes, but not necessarily, equal to depreciable life.

Profitability — a measure of the excess of income over expenditure during a given period of time.

Research Expense — those continuing expenses required to provide and maintain the facilities to develop new products and improve present products. A component of the annual expense statements of commercialized projects. See also development costs.

Risk — the degree of dispersion or variability around the expected or "best" value which is estimated to exist for the economic variable in question, e.g. a quantitative measure of the upper and lower limits which are considered reasonable for the factor being estimated.

Sales Buildup — historical or forecast sales volume, by years, (increase or decrease).

Sales Price — the revenues received for a unit of product. *Gross sales* price is the total amount paid. *Net sales* are gross sales less returns, discounts, freight and allowances. Plant *netbacks* are net sales less selling, administrative and research expenses.

Selling Expense — the total expense involved in marketing the products in question. This normally includes direct selling costs, advertising, and customer service.

Startup Costs — presale operating costs to bring the plant on stream. Includes employee training, equipment tests, process adjustments, as well as the usual manufacturing costs. It is generally assumed that no revenue is obtained from products made during this period. Frequently, part of this startup cost is capitalized.

Taxes Payable — tax accruals due with a year.

Variable Costs — raw material costs, by-product credits, and those processing costs directly proportional to plant output (such as utilities, catalyst and chemicals, packaging, and labor for batch operations).

Uncertainty — Unknown future events which cannot be predicated quantitively within useful limits, e.g. accidents which destroy invested facilities, a major strike, a competitors innovation which makes the new product obsolete, etc.

Major Profitability Yardsticks

Average Annual Cost — the conversion, by an interest rate and present worth technique, of all capital and operating costs to a series of equivalent equal annual costs. As a system for comparing proposed investments, it requires assumption of a specific minimum acceptable interest rate.

Breakdown Point — the percentage of capacity at which incomes of a company or facility just cover all variable and fixed costs. Depreciation normally included. See Shutdown Point.

Breakdown Price — the price, at 100% of capacity, at which incomes of a company or facility just cover all fixed and variable costs. Depreciation normally included.

Capitalized Costs — the present worth of the cost of renewing and operating a facility perpetually. As a system for comparing proposed investments, it requires assumption

of a specific minimum acceptable interest rate.

Cash Return, Per Cent of Total Capital — ratio of average depreciation plus average profit, to total fixed and working capital, for a year of capacity sales. Otherwise, same as return-on-original-investment. Under certain limiting conditions, this figure closely approximates that calculated by profitability index techniques.

Discounted Cash Flow — See Profitability Index.

Interest Rate of Return — See Profitability Index.

MAPI Method — a system of analysis based fundamentally on the discounted cash flow procedure. By formula approach it compares making an investment now with going on without investing for 1 more year. Easy to apply but should not be used where the assumptions built into the formula do not fit a particular situation.

Net Profit, Per Cent of Sales (Profit Margin) — the ratio of annual profits to total sales for a representative year of capacity operations. An incomplete measure of profitability, but a useful guidepost for comparing similar products and companies. Shows the sensitivity of profits to price changes.

Payout Time — the time required to recover the original fixed investment from profit and depreciation. Usually, but not always, after taxes and based on capacity operations. Also called pay-off or payback period. It is simple to calculate and can be used for evaluating many projects. It is not satisfactory for comparing projects with different lives or patterns of cost and earnings.

Present Value (Present Worth) — the discounted value of a series of cash flows at any arbitrary point in time. Also, the system of comparing proposed investments which involves discounting at a known interest rate (representing a cost of capital or a minimum acceptable rate of return) in order to choose the alternate having the highest present value per unit of investment. This technique eliminates the occasional difficulty with P.I., of multiple solutions, but has the troublesome problem of choosing or calculating, a "cost of capital" or minimum rate of return.

Profitability Index (P.I.) — the rate of compound interest at which the company's outstanding investment is repaid by proceeds from the project. All proceeds from the project, beyond that required for interest, are credited, by the method of solution, toward repayment of investment by this calculation. Also called discounted cash flow, interest rate of return, investor's method, internal rate of return. Although frequently requiring more time to calculate then the preceding yardsticks, P.I. reflects both the dollar and the time values of all money involved in a project. In some very special cases, such as multiple changes of sign in cumulative cash position, false and multiple solutions can be obtained by this technique.

Rate of Return on Investment — the efficiency ratio relating profit or cash flow incomes to investments. Several different measures of this ratio are in common use.

Return on Average Investment— the ratio of annual profits to the average book value of fixed capital, with or without working capital. This method has some advantages over the return-on-original investment method. Depreciation is always considered; terminal recoveries are accounted for. However, the method does not account for the timing of cash flows and yields answers that are considerably higher than those obtained by the return-on-original-investment and profitability index methods. Results may be deceiving when compared, say, against the company's cost of capital.

Return on Original Investment — the ratio of expected average annual after tax profit (during the earning life) to total investment (working capital generally included). Similar in usefulness and limitations to payout.

Shutdown Point — the production level at which it becomes less expensive to close the plant and pay remaining fixed expenses out-of-pocket, rather than continue operations. See Breakeven Point.

Turnover Ratio — the ratio of annual sales to investment. Inclusion of working capital is preferable but not always done. Considered by some to be a reasonable basis for a guestimate of facilities cost, for new products similar to existing products. Ranges around 1.0 for many chemical plants. The product of turnover ratio and profit margin on sales gives a return on investment measure.

Unified Code System—II

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Developing and defining a cost code system that can be generally applied requires precise and systematic study. The theory of sets, which deals with the mathematics of collection of items or objects, has been found initially helpful in developing such a unified code system. But if all cost engineers analyzed the same problem with the same mathematics, a real start would be made to obtaining a standard glossary of universally applicable terms.

The ideas presented here concern the classifying, relating and ordering of concepts to permit clear thinking about complex qualitative situations and discrete matters — the latter being anything composed of distinct parts or discontinuous elements. The simplicity of the ideas, abstracted into a symbolic system, belies the principal difficulty of the subject.

Principles of Set Theory

The concept of *set* or *class* or *collection* is recognizable in daily experience. Automobiles in a parking area, letters in the alphabet, coins in a cash register — each of these constitutes a set. The individual automobiles, letters and coins are the elements or members of the respective sets.

Almost any ruling expression can define a set, if we can decide from it whether an element of interest satisfies the rule. If it does, then the element belongs to the set. If $\underline{a}$ is an element of the set $\underline{A}$, this can be expressed:

$$\underline{a} \in \underline{A}$$

where *epsilon* is read, "belongs to," "is an element of" or "is a number of."

If $\underline{a}$ is not an element of a set $\underline{B}$, this is symbolized by:

$$\underline{a} \Phi \underline{B}$$

where the *Phi* reads "does not belong to."

In deriving cost codes, we are interested in knowing when an element belongs, or does not belong, to a set of accounts. From theory, a set may be described in two ways:

- List all elements of the set.
- State a condition that is satisfied only by the elements of the set and by no others.

The former is called the tabulation, or roster, method; the latter, the rule method.

If a set has infinite elements, the tabulation method is not appropriate; the rule method is. If a finite number of elements is involved, but if the elements can be listed only in a limited way, then again the rule method is required. The rule method, however, may be "necessary, but not sufficient" without some listing. Present practices of setting up code systems seem to require both tabulation and rule methods.

In the tabulation method, brackets are used to show that certain elements belong to a set:

$$\underline{N} = \{1, 3, 5, 7\}$$

$\underline{N}$ is a set having the elements 1, 3, 5 and 7.

When the rule method is used, it is conventional to denote a set as:

$$\underline{A} = \{ \underline{x} \mid \underline{x} \text{ has property } \underline{P}\}$$

$\underline{A}$ is the set of all elements $\underline{x}$, such that $\underline{x}$ has the property, or condition, $\underline{P}$. The brackets are read, "is a set," and the vertical bar is read "such that." To illustrate this specifically,

$$\underline{A} = \{ \underline{x} \mid \underline{x} \text{ is a coin in your cash register}\}$$

This is read, "$\underline{A}$ is a set of all $\underline{x}$'s such that $\underline{x}$ is a coin in your cash register."

Some typical sets useful in practice can be expressed similarly.

$$\underline{S}_1 = \{ \underline{x} \mid \underline{x} \text{ is any cost of manufacture}\}$$

$$\underline{S}_2 = \{ \underline{x} \mid \underline{x} \text{ is a cost of manufacture in Dept. 24}\}$$

$$\underline{S}_3 = \{ \underline{x} \mid \underline{x} \text{ is a cost of manufacture in operation 18 of Dept. 24}\}$$

In a business firm, construction of new sets having special properties is continuous. The addition of new buildings or machinery or production centers, for example, creates completely new sets. This requires definition of a universal set that provides a flexible system, and that maintains precise, logical ways of defining subsets and arranging for their combinations or partitions.

If both $\underline{A}$ and $\underline{B}$ are sets, $\underline{A}$ is a subset of $\underline{B}$ if every element of $\underline{A}$ is also an element of $\underline{B}$. Conversely, $\underline{B}$ is a superset of $\underline{A}$.

Symbolism for a subset is:

$$\underline{A} \subset \underline{B}$$

where the *inclusion* symbol means "is a subset of."

For example, let $\underline{B}$ be the set of whole numbers, and let $\underline{A}$ be a set of even numbers. $\underline{A}$ is a subset of $\underline{B}$. If, on the other hand, $\underline{B}$ is a set of real numbers, then $\underline{A}$ is also a subset.

A particular set may be a subset of more than one set. A *proper* subset is one in which every element of $\underline{A}$ is an element of $\underline{B}$, but there is at least one element of $\underline{B}$ that is not an element of $\underline{A}$. In other words, $\underline{A}$ is not equal to $\underline{B}$. When $\underline{B} = \underline{A}$, then

$$\underline{B} \subset \underline{A}, \text{ and } \underline{A} \subset \underline{B}$$

$\underline{A}$ is a proper subset of $\underline{B}$ in the following illustration:

$$\underline{B} = \{ \$ \mid \$ \text{ is total cost of material and labor for manufacture}\}$$

$$\underline{A} = \{ \$ \mid \$ \text{ is total cost of material for manufacture}\}$$

Further Principles of Theory

If applied in the example above that includes Dept. 24, and there were no material account, then

$$\underline{A} = \Theta$$

which reads: $\underline{A}$ is the empty, or null, set. $\underline{A}$ has no elements in this case. All sets include the empty set, and this important concept finds use in an accounting system.

Another classification is the disjoint set, where no element of set $\underline{A}$ is an element of set $\underline{B}$ and vice versa; i.e., $\underline{A}$ and $\underline{B}$ have no elements in common.

For many practical or applied purposes, all sets under discussion are subsets of one particular set. This set is then the universal set $\underline{U}$ for a particular discussion. It may change for other discussions.

In completing a collection of subsets, the following properties must be met:

1. The union of any two sets from the same class is again in the class. The symbol $\cup$ denotes union.

2. The intersection of any two sets from the class is again in the class. The symbol $\cap$ denotes intersection.

3. The complement of any set from the class is also in the class. The symbol $\overline{A}$ denotes complementation.

The class is then closed, in the sense that we cannot get outside of it by these operations, which are treated in the next section.

In mathematics, we are interested in operations that are closed, for then we are free to perform operations and be assured that the results are not outside the defined set of elements.

To summarize, if Y is a collection of subsets of a given set U, then Y is an algebra of sets, if whenever

$$\underline{A} \in Y \text{ and } \underline{B} \in Y,$$
$$\text{then } \underline{A} \cup \underline{B} \in Y,$$
$$\underline{A} \cap \underline{B} \in Y, \text{ and } \overline{\underline{A}} \in Y.$$

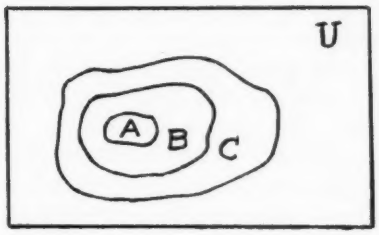


Figure 1

Every condition in a universal set $\underline{U}$ yields a subset $\underline{u}$, namely the set of all elements of $\underline{U}$ that satisfy the the condition. The set of all subsets of $\underline{U}$ is the largest possible algebra of sets.

In general, then, sets are formed from a set $\underline{M}$ according to what is known as a set builder:

$$\{ \underline{x} \in \underline{M} \mid \underline{p}(\underline{x}) \}$$

or

$$\{ \underline{y} \in \underline{M} \mid \underline{p}(\underline{y}) \}$$

which is read "the set of all elements $\underline{x}$ of $\underline{M}$ for which $\underline{p}(\underline{x})$ is true." The $\underline{p}(\underline{x})$ is an abbreviation for the expression "$\underline{x}$ satisfies the condition $\underline{p}$." The set is called the truth set in $\underline{M}$ for condition $\underline{p}$. In any cost-code system, each time that values or conditions are set for the elements, a set is established.

To stipulate values and conditions might in some cases require elaborate instructions. A universal set may require either explicit or implicit instructions. The most useful and practical subsets would be those that are well-defined by a simple rule or set of instructions. In cost engineering, the elements assume values depending on time and circumstances.

Set Theory Operations

The union, intersection and complementation of sets can be illustrated by Venn diagrams and by set-theory symbolism. If we consider the universal set $\underline{U}$, the following are operations relating to subsets:

Inclusion	$\underline{A} \subset \underline{B}$
Union	$\underline{A} \cup \underline{B}$
Intersection	$\underline{A} \cap \underline{B}$
Complementation	$\overline{\underline{A}}$
Difference	$\underline{A} - \underline{B}$

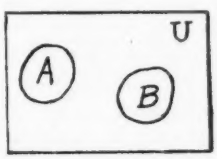
Inclusion. If $\underline{A}$, $\underline{B}$ and $\underline{C}$ are sets having the relationship $\underline{A} \subset \underline{B}$ and $\underline{B} \subset \underline{C}$ then the Venn diagram, Fig. 1, represents the case.

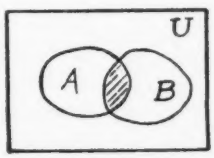
For example, let $\underline{U}$ be the set of all costs of manufacture for a company. Let $\underline{C}$ be the set of all costs of manufacture for some one department. Let $\underline{B}$ be the set of all costs of manufacture for one operation in that department. Let $\underline{A}$ be the cost of labor for that operation. Then $\underline{C}$ is a subset of $\underline{U}$; $\underline{B}$ is a subset of $\underline{C}$; $\underline{A}$ is a subset of $\underline{B}$.

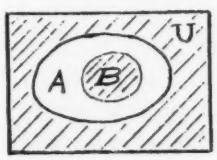
Union. Though similar to arithmetic addition, this operation is also distinctly different. Like elements aren't additive. The collection concept of discrete entities doesn't permit loss of identification of the entity.

As an example, let the sets of material and of labor for one department be represented by $\underline{M}$ and $\underline{L}$, where $\underline{M}$ and $\underline{L}$, represent the set elements. If these two sets form a union with another department having sets of $\underline{L}$ labor and $\underline{E}$ energy the "logical sum" has $\underline{M} + \underline{L} + \underline{E}$ elements in it. The simple arithmetic sum gives $\underline{M} + 2\underline{L} + \underline{E}$. The union of sets can be denoted by

$$\underline{A} \cup \underline{B} = \{ \underline{x} \mid \underline{x} \text{ belongs to } \underline{A}, \text{ or } \underline{x} \text{ belongs to } \underline{B} \}$$







Figures 2a, 2b, 2c

There are three cases represented in Fig. 2.

Intersection. We might wish to denote the set of elements common to $\underline{A}$ and to $\underline{B}$. Let $\underline{U}$ be given and $\underline{A} \subset \underline{U}$ and $\underline{B} \subset \underline{U}$, then

$$\underline{A} \cap \underline{B} = \{\underline{x} \mid \underline{x} \in \underline{A} \text{ and } \underline{x} \in \underline{B}\}$$

In the above example of material labor and energy, let $\underline{A}$ be materials and labor, $\underline{B}$ be labor and energy. Then $\underline{A} \cap \underline{B}$ = labor. The shaded portion in Fig. 2b represents $\underline{A} \cap \underline{B}$; the total projected and overlapping areas of $\underline{A}$ and $\underline{B}$ represent $\underline{A} \cup \underline{B}$.

Complementation. This concept is, as one author states, vital. The complement of a set is always with reference to a particular universal set. By definition, let $\underline{U}$ be given and $\underline{A} \subset \underline{U}$; then

$$\overline{\underline{A}} = \{\underline{x} \mid \underline{x} \in \underline{U} \text{ and } \mathbf{x} \notin \underline{A}\}$$

The outer shaded area in Fig. 2c represents $\overline{\underline{A}}$.

There are a number of theorems or laws that enable us to prove the true relationship involving subsets, union, intersection, complementation and inclusion. In setting up a code system, these should prove invaluable, especially when sets are defined by the rule method. Some are given below:

Idempotent
$$\underline{A} \cup \underline{A} = \underline{A}$$
$$\underline{A} \cap \underline{A} = \underline{A}$$

Commutative
$$\underline{A} \cup \underline{B} = \underline{B} \cup \underline{A}$$
$$\underline{A} \cap \underline{B} = \underline{B} \cap \underline{A}$$

Associative
$$\underline{A} \cup (\underline{B} \cup \underline{C} = (\underline{A} \cup \underline{B}) \cup \underline{C}$$
$$\underline{A} \cap (\underline{B} \cap \underline{C}) = (\underline{A} \cap \underline{B}) \cap \underline{C}$$

Distributive
$$\underline{A} \cap (\underline{B} \cup \underline{C}) = (\underline{A} \cap \underline{B}) \cup (\underline{A} \cap \underline{C})$$
$$\underline{A} \cup (\underline{B} \cap \underline{C}) = (\underline{A} \cup \underline{B}) \cap (\underline{A} \cup \underline{C})$$

The idempotent laws are quite different from anything familiar in arithmetic. Unlike arithmetic addition, a set added to itself does not result in a gain.

The commutative laws enable us to form unions and intersections *in any order*. There are systems in mathematics, however, where this doesn't hold. If an algebra were set up for the wood room in our company, certain operations would not commute. The order of chipping and screening, for example, is important.

The associative laws give us the right to form unions of more than two sets, or to form intersections of them. But the law does not apply to mixtures of unions and intersections. The distributive laws answer questions of how to expand or to contract mixtures of unions and intersections.

A set, its subsets, and the laws of their combinations, form what is known as Boolean algebra. The systems can be studied from a logical point of view, as well as from a strictly algebraic point of view.

Set Functions

In a code system of interest to cost engineers, sets would have characteristics measured by numbers. Further, for universal sets it would be necessary that the sum of the numbers — dollars or some other unit of money — would be the additive effect of all the sets comprising $\underline{U}$.

Many different kinds of universal sets seem necessary to stipulate various classes of costs. The sum of all sets that might be derived for the system would neither be of value nor required.

Suppose, in a particular manufacturing plant, there are four departments — $\underline{a}$, $\underline{b}$, $\underline{c}$ and $\underline{d}$ — that contribute to a cost in the amount of 9, 7, 3 and 1 thousand dollars respectively. The set $\underline{A} = \{\underline{a}, \underline{b}\}$ has \$16m and the set $\underline{B} = \{\underline{c}, \underline{d}\}$ has \$4m (where m means thousands). Here, if the cost for $\underline{A}$ is added to the cost for $\underline{B}$, we obtain the total cash for the union $\underline{A} \cup \underline{B}$. This simple example shows that the additive property holds only if the sets are disjoint.

If set $\underline{C} = \{\underline{a}, \underline{b}, \underline{c}\}$ and set $\underline{D} = \{\underline{b}, \underline{c}, \underline{d}\}$, we do not get the cost for the union $\underline{C} \cup \underline{D}$. An additive set function is defined by one author as follows: Let $\underline{V}$ be a finite set, and let $\underline{A}, \underline{B}, \underline{C}, \ldots$ be subsets of $\underline{V}$. Let $\underline{f}$ be a function that assigns to any subset $\underline{S}$ of $\underline{V}$ a real number $\underline{f}(\underline{S})$, such that if $\underline{A}$ and $\underline{B}$ are disjoint subsets of $\underline{V}$,

$$\underline{f}(\underline{A} \cup \underline{B}) = \underline{f}(\underline{A}) + \underline{f}(\underline{B})$$

Then $\underline{f}$ is called an additive set function.

To achieve additive properties for sets that are not disjoint,

$$\underline{f}(\underline{A} \cup \underline{B}) = \underline{f}(\underline{A}) + \underline{f}(\underline{B}) - \underline{f}(\underline{A} \cap \underline{B})$$

One special class of additive set functions is called a weight function. By definition, a weight function $\underline{w}$ is an additive set function, all of whose values are positive or zero.

$$\underline{w}(\underline{S}) \geq 0, \text{ for all subsets } \underline{S} \text{ of } \underline{V}$$

The function is called a probability function when the total weight of the universal set is the unit of weight. It is probable that probability and statistical techniques could be more easily and properly applied to systems that have been devised in accordance with set theory concepts.

In the development of a universal set, one of the aims is to have it suit many purposes. For any one situation, certain subsets may be of more importance than others. Nor is it necessary to be interested in all possible subsets. For those subsets that are judged important, however, so are their unions, intersections and complements.

It is important in classification to be interested in two aspects of sets:

1. Their definitions and element descriptions.
2. Their real values.

It might also be important, in certain cases, to treat the order in which the elements appear in a set, or the subsets of the sets, universal or otherwise. The latter implies concern as to permutations and combinations. For example, how many different subsets can be obtained for a given set?

In deriving a cost-code system, a number of definitions were developed and are to be found in the Appendix. In listing elements, each was tested for inclusion or exclusion according to the definition on hand. To claim 100 percent nonambiguity for elements would be stretching a point. The great majority, however, were quite clear issues. The nature of the way the sets are developed makes any trivial issue still less important for the number of purposes to which the code is being used.

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7. National Assn. of Accountants, "Classification and Coding Techniques to Facilitate Accounting Operations," Research Report No. 34, New York, 1959.
8. School Mathematics Study Group, "Mathematics for High School, Elementary Functions (Part 1)," Yale University, 1959.

Appendix

The following is a brief glossary of terms:

Set — Any class or collection of anything so defined that it is possible to decide for any element therein, whether or not it satisfies the imposed rule or stipulation. Symbol: $\underline{A}, \underline{B}, \underline{C} \ldots$

Element — The individual components of a set that are definable or identifiable by the rule or roster that distinguishes the characteristics of the set and membership in it. Symbol: $\in$; $\underline{a} \in \underline{A}$ reads "$\underline{a}$ is an element of the set $\underline{A}$."

Universal set — That which contains all the elements and sets in which one is interested and excludes these from all others. Symbol: $\underline{U}$

Set function — A function that assigns a real number to any subset of the universal set. Symbol: $\underline{f}$ is the function, $\underline{f}(\underline{S})$ is its value for set $\underline{S}$.

Null set — A set that has no elements. The empty or null set is always assigned the probability zero. Symbol: Θ

Finite set — A set that contains a finite number of elements.

Subset — A set whose elements are contained in another set.

Proper subset — One that is neither empty nor contains all the elements of the given set.

Rule method — That which defines the elements of a set by a rule.

Roster method — That which defines the elements of a set by listing.

Venn diagram — A schematic representation of a universal set and subsets.

The department — The summation of labor, material, overhead, property and equipment, and the housing thereof, necessary to produce a product or service.

The operation — A contiguous arrangement of production or service elements that affects a special contribution to a product or service.

The property and equipment — Single production or service element within an operation.

The primary elements — Labor, materials and overhead necessary for the installation, operation and maintenance of property and equipment.

Component — Parts of a property-and-equipment asset that are temporarily segregated until work is in place.

Authorization — Transient classification for the collection of data on a specific job.

Labor — An individual's effort expended, directly or indirectly, to convert material into a product or asset. Indirect labor is that not applied directly toward the realization of a product or asset.

Material — Those commodities that are obtained to be converted into, or otherwise become a principal part of, a product or asset. Those which cannot be so identified are known as indirect materials or supplies.

Overhead — Expenses that, without arbitrary proration, cannot be charged to or identified with a product or asset. The extent to which costs or other values are identifiable with a product or asset is dependent on codes, systems and their administration.

Product — Anything produced by generation, growth, labor or thought.

Current Cost Capsules

ANNEAR, R. C., AND COLE, W. A. "Iron Mining Methods and Costs, Greenwood Mine, Ishpeming, Mich.," *Bureau of Mines Inf. Circ.* 7971, 1960, 36 pp.

Describes mining methods of iron ore mine in Michigan and gives direct mining costs and general expenses.

ASMAN, ARNOLD W. "Belt-Haulage Economics," *Coal Age*, vol. 65, No. 10, (October 1960), pp. 112-114, 116.

Illustrates the cost of transportation by belt conveyor. Belt-conveyor specification lists approximate selling prices, delivered, as $200,00.

ARROYAVE, E. A. "Industrial Construction Costs in Latin America," *Cost Eng.*, vol. 5, No. 3, (July 1960), p. 4.

Discussion of labor problems and wage rates in Columbia and Venezuela. Accompanying tables show basic wage rates for construction labor, some principal items of some Latin American labor codes, labor benefit schedules and a table of man-hour ratios for construction compared to United States man-hours.

BAUMAN, H. C. "Estimating Time of Construction," *Ind. Eng. Chem.*, vol. 52, No. 8, (August 1960), pp. 59A-61A.

Estimates of time of construction and startup — one of the most important elements of the fixed capital cost estimate — tend to be optimistic. Only 1/3 of a representative number of recent completed projects were on, or ahead of, schedule. It took a median of 27 months to complete and startup plants over $5 million in value. Time ranged between 19 months for a simple process fluid plant to 42 months for a complex chemical, fluid and fluid-solid project.

BERRY, RICHARD M. "Estimate Manufacturing Costs," *Chem. Eng.*, vol. 67, No. 13, (June 27, 1960), pp. 123-126.

On basis of research and development data, estimates can be made of unit manufacturing cost by this method. Method is illustrated in numerical example of its use, and it depends on working up correlation of conversion cost vs. production capacity with number of major process steps as parameter.

BRANDON, D. B. "Let a Digital Computer Run Your Alkylation Plant," *Ind. Eng. Chem.*, vol. 52, No. 10, (October 1960), pp. 814-820.

Computers permit improved control and maintenance of plant conditions close to optimum. The objective is normally stated in monetary terms. An example shows how to maximize the dollar gain from alkylation subject to various constrains on operating conditions.

CHEMICAL WEEK. "Fuel Gas Reshapes Coke Chemicals Outlook," vol. 86, No. 17, (April 23, 1960), pp. 53-54.

Explains use of coke-oven, natural, or fuel gas as blast furnace reducing agent. Pittsburgh Coke and Chemical has used coke-oven gas successfully in this medium and has shown a saving of $2.10 per ton of iron produced.

FORBATH, T. P. "Multiple or Single Building Contracts?" *Chem. Eng.*, vol. 67, No. 15, (July 25, 1960), pp. 53-55.

Dow Texas Div. claimed competitive lump-sum bids lowered construction costs 15% from detailed estimate, saved 3½ months of construction time in typical multi-million dollar project handled this way. Periods 1951-52 and 1957-58 had nearly same dollar volume of construction but contractor manpower in latter period was less than half of former. Fluor claimed labor productivity gains probably accounted for most of gain.

FRYBACK, M. G., AND HUFNAGEL, J. A. "Process Design of Distillation Columns and Related Equipment," *Ind. Eng. Chem.*, vol. 52, No. 8, (August 1960), pp. 654-661.

Investment and operating costs versus reflex ratio for 120,000 bpsd debutanizer shows that the most economical design trend is toward additional trays and lower reflex ratio. Costs of four main types of trays are frequently as high or higher than the tower proper.

KATELL, SIDNEY, FABER, JOHN H., AND DOUGLAS, JOHN W. "Bibliography of Investment and Operating costs for Chemical and Petroleum Plants, January — December 1959," *Bureau of Mines Inf. Circ.* 7966, 1960, 68 pp.

Annual bibliography listing cost articles published in 1959.

(A copy of this bibliography was sent to all AACE members.)

KETNER, S. E. "Minimize Batch Equipment Cost," *Chem. Eng.*, vol. 67, No. 17, (August 22, 1960), pp. 121-124.

Discusses mathematical methods to calculate optimum equipment size for batch processes, showing derivation and use. Three numerical examples show how total installed cost is obtained for flowsheets of increasing complexity.

KING, JOHN A. "U. S. Ammonia Feels Foreign Impact," *Chem. Eng.*, vol. 67, No. 14, (July 11, 1960), pp. 82-84.

General economic article on ammonia capacity and production details, utility requirements and capital costs for various processes.

KUONG, J. F. "Sum-of-Years Depreciation," *Chem. Eng.*, vol. 67, No. 23, (Nov. 14, 1960), pp. 236, 238.

Presents nomograph to determine the annual depreciation payment figured by sum-of-the-years method. Total depreciable value scale ranges from $1,000 to $10,000.

LEWIS, W. B. "Competitive Nuclear Power for Canada," *Nucleonics*, vol. 18, No. 10, (October 1960), pp. 54-59.

Expected cost of power compared in Ontario's nuclear and conventional plants. The fuel charge for natural uranium fuel in a CANDU-type reactor will be 1 mill per kw.-hr. and will make a base-loaded plant competitive with coal-fired plants operating on the Ontario power grids.

MACCARY, RAYMOND R. "How to Select Pressure-Vessel Size," *Chem. Eng.*, vol. 67, No. 21, (October 17, 1960), pp. 187-190.

Presents methods to size pressure vessels for economical dimensions and to get optimum size for minimum surface area. Gives numerical example for each problem.

MARSHALL, J. M. "Rundown on Saline Water Conversion." *Chem. Eng.*, vol. 67, No. 15, (July 25, 1960), pp. 105-108.

Description of 5 demonstration programs of OSW for saline water processing. Includes investment and unit costs for multiple effect, long-tube vertical evaporation; multi-stage flash distillation; electrodialysis; forced-circulation vapor compression; and freezing. Predicted costs ($/1,000 gal.) are repectively: $1.00, $1.20, $1.00, $1.10, and $1.00.

MCGEE, JAMES P., AND KATELL, SIDNEY. "Possibilities of Using Nuclear Energy for Gasifying Coal," *Bureau of Mines Inf. Circ.* 7965, 1960, 11 pp.

Describes the possibilities of using nuclear energy for coal gasification. Includes table comparing the economics of nuclear heater steam coal gasification versus conventional oxygen steam coal gasification.

News from the Regions

BRITISH GROUP

The officers of the British Group held an August 9th meeting at Kellogg House in London.

The first item for discussion was the formation of a Reference Library; and Mr. Herbert disclosed that the Kellogg Company had given permission for their library facilities to be used and the services of their librarian, Mrs. Marsland, to be made available to all members of the Association. It was decided that all members should be circularized to obtain lists of personal literature that they would be willing to make available to fellow members. Mrs. Marsland, who attended the meeting, suggested that she contact as many sources of useful information as possible, such as the Institute of Works Management, Cost and Works Accounts, and draw up a bibliography of available literature to be distributed to the members. It was agreed that arrangements should be made for borrowing of literature in members names from Professional Institutes. The technical library service was to start September 1st and members can contact Mrs. Marsland by letter or by phone during business hours.

It was unanimously decided that to enable branch members' particular fields of interest to become known all members would be asked to fill out a duplicate application form to be retained by the section.

Mr. Herbert proposed that a draft constitution based on a copy of the Gulf Coast Section's constitution be drawn up and submitted to the group for discussion.

A general discussion regarding the possibility of a meeting for all members during November followed and the presentation of a paper was suggested. No final decision was made.

The question of publicity next arose, but it was agreed by all that until we had received the parent association's approval it would not be wise to go ahead with the schemes envisaged.

It was agreed that the third Wednesday in every month would be suitable for future committee meetings, with the exception of the next meeting, which will be held on Friday, September 23rd.

The September 23rd meeting was held at Kellogg House, London.

A draft constitution was submitted for discussion; and, after alterations, it was arranged to send copies of the final draft to all members asking for comments.

Mr. Herbert reaffirmed that the library facilities were now available to members but that Mrs. Marsland had not yet managed to complete a bibliography of the literature available. The secretary will inform all members and send out a questionnaire so that members may record their individual spheres of interest.

After some discussion it was agreed that the secretary should make it quite clear to all potential applicants that, though a U. S. organization, the British section of the association will be for purely European interests, but will have the advantage of our parent association's experience and advice.

The first public meeting was held on December 12 at the Institution of Civil Engineers. There were more than one hundred people present, representing a wide range of companies and industries. This meeting produced many volunteers who were interested in serving on committees and "workshops."

CHICAGO-MIDWEST SECTION

The October 20th meeting of the section was a dinner meeting held at Milner's Restaurant in Chicago with over 40 people in attendance.

The speaker of the evening was Mr. Harry A. Quigley, Development Appraisal Department, Atlas Powder Company, Wilmington, Delaware. Mr. Quigley is a Senior Economic Evaluation Engineer concerned with profitability evaluation of proposals for capital expenditure at Atlas. His topic was "Comparison of Profitability Index and Present Value Techniques".

Chairman Warren W. Twaddle, in his November 9th Newsletter to the membership, reported on the section's first experiment in workshop meetings held Thursday, November 17. There were three concurrent workshops on special phases of capital estimating. Each of the three workshops was repeated and about 50 minutes allocated for each session. This gave each person the opportunity to attend two of the three workshops. At each workshop there was at least one authority in the field who participated in the discussion. The topics, along with the authorities, were as follows:

(1) Electrical Estimating — Ray Ashley, Electrical Consultant

(2) Sheet Metal Estimating — Larry Paul, President, Narowetz Htg. & Ventilating Corp.

(3) Piping Estimating — John Mark, Chief Estimator, Pure Oil Company.

Concurrent with the workshops was a Profitability Committee meeting which remained in session for the entire period. Henry Thorne, the section's national representative on the Profitability Committee, presided over this section. The long range goal of the committee is "to define and develop a minimum set of information necessary for valid appraisal for investment reported and risk", and the development of a Profitability Manual is

planned as a means of approaching this goal. The definitions developed last year by the committee are the first section of this manual; and work this year will aim at adding to this, with at least part of the work being suitable for presentation at the June, 1961 national meeting. The objective of the November meeting was to plan this year's activities for the Chicago Section and subdivide the group into areas of common interest. According to the plan, this will result in buzz sessions on topics such as appraisal of new projects, evaluation of research projects, and application of profitability on modification or replacement of existing plant equipment.

Mr. Twaddle reports that the section has taken membership in the College Technical Societies Council, a group which joins 46 technical societies in Chicago. This Council has established science clubs in local high schools and someday hopes to have its own building for use by the technical societies. The section hopes to gain broad publicity through the Council's Sci-En-Tech News Bulletin.

The January 26th meeting of the section was well attended by 52 people. The program commenced with a tour of the $34,000,000 McCormick Place, the new Chicago Exposition Hall located on the Chicago lake front. The size of the building was emphasized by its hallways which look to be a city block in length. The group visited the "President's Walk" restaurant, heard about the large theatre, and visited the huge main display hall. The facilities here are said to provide one of the best meeting locations in the world, and it was of great interest to the group to see how this building was planned and constructed.

Mr. Cecil H. Chilton, Editor-in-Chief of *Chemical Engineering* and author of the recent book, "Cost Engineering in the Process Industries," was the guest after-dinner speaker. He gave a fine talk entitled "The Soaring or Souring '60's" — emphasis on the soaring. His talk centered around the results of a recent study forecasting our national growth into 1975 by the McGraw-Hill Department of Economics. This was neatly integrated with trend analysis including new developments and their impact on various industries.

Cost workshops on Operating Cost, Profitability, and Capital Cost were featured at the February 16th meeting of the section. The roundtable discussions under the Operating Cost Workshop were moderated by Stephen H. Boll of Motorala Company and featured the subject of "Operating Costs, Estimating Problems and Procedures"; Henry C. Thorne of AMOCO moderated the Profitability Workshop on "Correlation Useful in Profitability Analysis"; and the Capital Cost Workshop on "Heavy Construction Costs — Earthwork, Concrete and Roadwork in Public Works and Industry" was moderated by E. John Mark of The Pure Oil Company, Thomas Roche of Cook County Highway Department and Vernon Ciske of Meissner Engineers. Of the 30 people present for the workshops, there were 14 in heavy construction, 7 in profitability analysis and 9 in operating costs. The latter group, which met for the first time, found that they had many problems in common.

The March 16th meeting, held at Stouffer's Restaurant, featured as speaker Mr. Charles R. Hort, of Procter and Gamble Company, Cincinnati, Ohio, who is our new National President and past Chairman of the National Capital Cost Control Committee. His topic was "Cost Control, A Scheme of Science and Sense".

The section is hard at work on an all-day symposium on Capital Costs to be held May 8 at the Furniture Club, 666 North Shore Drive.

POTENTIAL CINCINNATI AREA SECTION

An informal meeting for the Cincinnati area members of the American Association of Cost Engineers was held on January 11 at the Engineering Society of Cincinnati Building. The purpose of the meeting was to discuss the organization of a regional section of the AACE.

DELAWARE VALLEY SECTION

The November 28th dinner meeting of the Delaware Valley Section was held at the Philadelphia Engineers Club.

Featured speaker was Dr. L. W. T. Cummings from the Technical Economics staff of Sun Oil Company, whose topic was "Design, Planning and Profitability of New Plants". Some typical concepts discussed by Dr. Cummings were:

(a) the economic advantages of early construction completion

(b) the estimator's role in improving the profitability of new plants

(c) How can profitability potential be improved?

(d) What elements in the design and construction of a new plant will increase its ability to produce profit?

Mr. Dick Balotti of DuPont, Inc. spoke at the January 22nd meeting of the Delaware Valley Section. His topic, "Unified Code System", proved to be of great interest to the members of the group.

The March meeting is scheduled for March 27th at the Engineers Club in Philadelphia. Walter Cosinuke of Catalytic Construction Corporation will speak on "Critical Path Planning and Scheduling Effects on Cost".

GULF COAST SECTION

During the September 23rd meeting of the Gulf Coast Section a report was presented by Aaron Cohen, who, with Vermon Mills, represented the cost engineers at the last meeting of the Engineer's Council. The Council is preparing a roster of speakers, and the request was made that the section's members step forward to tell Mr. Cohen the subjects on which they would prefer to speak, in order that he might register this information in the proposed roster.

Following the business meeting, Mr. T. M. Ballew, Sales Manager of the Texas Employer's Insurance Company, spoke on "Safety, Profit or Loss?". Mr. Ballew is a graduate of A & M with a B.A. in Electrical Engineering. He was formerly with the Engineering Department of Texas Employer s Insurance Company, and is a registered engineer with the state of Texas. The meeting was adjourned after a question and answer period concerning insurance, its coverage and the actual expense of accidents as a part of the cost of construction.

At a meeting of the section's Board of Directors on November 18th, the decision was made by the Directors to hold monthly meetings in January, February, and March.

Duncan Allan, Secretary of the Gulf Coast Section, made a motion to refer to the Constitution Committee for action changes of title from Chairman to President and Vice-Chairman to Vice-President. The motion was seconded by John Haselbarth and passed.

There followed a discussion of the various committees and plans were made to stimulate their activity. The suggestion was made that the Technical Committee be divided into a number of sub-heads such as Profitability, Capital Cost and so forth to be responsible for activity in the various fields and that each committee prepare at least two papers per year on their topic.

There was also a discussion concerning the Cost Engineer's providing an exchange of cost data with the possibility that information regarding construction elements and other items in the Gulf Coast area might be printed in a national publication as the product of the Gulf Coast Section.

The December 2nd dinner meeting of the Gulf Coast Section was held at the Houston Engineering & Scientific Society Building.

A color movie, "Erection of Isomerization Tower at the City Service Refinery in Lake Charles, Louisiana", which was concerned with interesting aspects of the erection of the largest single piece erection in the Gulf Coast Area, was presented. This tower is 212 feet high, 14 feet in diameter and weighs 235 tons. The introduction was given by Mr. Ray Rohrdanz, Construction Manager of Tellepsen Petro-Chem Constructors, and the commentary by Mr. A. V. Looper, Direction Superintendent for Champion Constructors.

The January 27th meeting of the section was a business meeting without a special program.

A request was made by Aaron Cohen for members to judge the computer exhibits at the Science Show.

Aaron Cohen made a motion that the group go on record as approving and promoting zoning for Houston. Due to the lack of unanimity among the membership, the motion was tabled by Norman Bach.

Duncan Allen made an apeal to the members to submit unit cost data of various units of construction and cost equipment, both machinery and vessels, for process plants. The information would then be published and distributed to the membership each month with the regular meeting announcement. No company or individual name would be shown as the source of this information unless specifically requested.

Art Weber asked for volunteers as chairmen for the various technical committees. Mr. J. Schewe will chair the Capital Cost Estimating Committee, J. N. McGuiness will chair the Capital Control Committee, John Haselbarth will chair the Profitability Committee, and Duncan Allen, the Cost Indexes Committee.

An appeal was made by Aaron Cohen to support the Water Development Program promoted by the Texas Society of Professional Engineers.

E. D. Redding tendered his resignation, much to the regret of the membership. It was requested that all members help Dan Chisholm, Membership Committee chairman, by obtaining at least one new member each three months of this year.

POTENTIAL MONTREAL SECTION

Mr. C. A. Miller, past president of the AACE, addressed a group of 31 members and guests on the subject of "Short Cut Method for Estimating Buildings" at the December 8, 1960 meeting of the potential Montreal Section.

Unanimous approval was given to the suggestion that the acting officers:

J. W. Hackney President
C. A. Miller Vice-President
J. H. Boudreau Secretary-Treasurer

continue their duties until the 1961 annual meeting.

Forty-nine members and guests attended a dinner meeting on January 16, 1961, at which Mr. Cecil H. Chilton, Editor-in-Chief of *Chemical Engineering* and treasurer of the AACE, delivered a talk entitled "The Soaring or Souring Sixties". The Montreal Section is

grateful to Mr. Chilton for taking the time to prepare and deliver such an informative and optimistic talk.

Mr. John W. Hackney presented an interesting paper at the February 14th meeting on "Preliminary Capital Cost Estimation — Process Industries".

At this meeting the Regional Section Constitution and By-Laws approved by the members for submission to the AACE Board of Directors. Paid up membership now stands at 28, with 17 potential members.

METROPOLITAN NEW YORK SECTION

The fifth meeting of the executive committee of 1960-61 was held at the McGraw-Hill Building on January 2, 1961.

Arrangements for the forthcoming visit to the Con Edison Atomic Plant at Indian Point in March were outlined in detail by Don Brosnan. This trip has all the characteristics of success not only for section members but for other interested people not associated with the AACE presently. An ample supply of application forms and literature will be made available at Indian Point.

Ed Gibbons produced a draft of the revised constitution on which the Constitution Committee has been working. The main objective is to produce a standard and basic format to which each individual section can add by-laws to cover their local conditions. Wes Dodge contributed most of the work in producing this basic constitution. It will be presented at Boston and mailed to all national chairmen.

The fourth general meeting was held in the Advertising Club on Jnuary 10 with Chairman Cecil Chilton presiding.

Following a general outline by the chairman of some future events in the program for 1961, Joe Brown introduced the speaker of the evening, Mr. Donald W. Pulver of Rohm and Haas, who spoke on "The Use of Plastic in Construction". Mr. Pulver gave an excellent general review of the use of plastics in construction with particular application to buildings. Various plastic materials were described and samples of the materials were available at the meeting for examination. Mr. Pulver's breakdown of comparative cost between various plastic and conventional materials provided a useful economic appraisal based on initial investment cost and relative life and maintenance. Many questions were asked at the end of the talk which indicated a keen interest in this subject.

The fifth general meeting of the current year was held on February 15 at the Brass Rail Restaurant.

Cecil Chilton opened the meeting and briefly outlined the business covered at the national Board meeting held earlier in February in Boston.

Ed Gibbons introduced the first speaker of the evening, Mr. E. Rusch of General Electric, who presented a talk concerning economic comparison between electric and gas furnaces. Many economical studies were projected on the screen illustrating the highlights of his talk.

The second speaker of the evening, Mr. William Novak, Assistant Editor of the *Electric Construction and Maintenance Magazine,* was introduced by Cecil Chilton. Mr. Novak reviewed the advantages and problems of electric space heating; he presented some interesting examples to prove the advantages of this type of heating in selected installations over other types of heating units. The technique of electric heating is still in its early stages but cost comparisons available so far indicate a growing advantage for this type of heating source. An excellent technical reprint was available for those present at the meeting.

NEW ENGLAND SECTION

The November 22nd dinner meeting of the New England Section was held at the Massachusetts Institute of Technology.

Mr. John P. Ricciardi, State Commissioner of Public Works, spoke on "Cost Estimating as it Applies to Public Works and Industrial Construction".

The February 14th meeting of the New England Section was held at the Massachusetts Institute of Technology.

Mr. DeLamater advised that the technical program for the convention is well in hand. He invited all people of whatever society to publicize the convention. The section hopes to attract at least 400 members to Boston.

The national Board of Directors were guests at this meeting, and Mr. Edward Shanken, Executive Secretary, introduced the members of the Board to the group. Mr. Charles Hirt, national AACE President, said a few words to the group.

A film, "Construction of the Distant Early Warning Line Station at Thule, Greenland," was shown.

The March 14th meeting of the section featured Mr. Norman H. Parker, Manager of the Industrial Division of the Tower Iron Works, as speaker. His topic was "Problems of Estimating Process Equipment and Pressure Vessels".

NIAGARA FRONTIER SECTION

The November 14th meeting of the Niagara Frontier Section was well attended by 34 members and guests.

Speaker of the evening was Mr. Joseph Biamonte of Shields and Company, Investment Bankers, whose topic was "Investments for the Professional Man". As an

indication of the interest aroused, Mr. Biamonte's talk lasted fifteen minutes and the question and answer period nearly an hour and a half.

The December 10th meeting was a social affair including dinner and dancing at the Plantation Club in Niagara Falls.

On January 16th the section met at the Red Coach Inn with 15 members and guests in attendance. There was a brief business meeting at which the members approved the amendment to the By-laws to be attached to the constitution which has been submitted to the national Board of Directors for approval.

Following the business meeting a colored film on the Niagara Power Project was enjoyed by the men.

Mr. Paul J. Baron, Administrative Assistant to the Chief System Project Engineer of the Niagara Mohawk Power Corporation, was the speaker at the February 13th meeting held at the Red Coach Inn. His subject, "Capital Cost Engineering Procedure at Niagara Mohawk," included a discussion of NMPCO'S system of cost estimating, analysis and control and introduced a lively discussion period.

The March 13th meeting was held at the Boots and Saddle Restaurant in Niagara Falls. After-dinner guest speaker was Cecil H. Chilton, Editor-in-Chief of *Chemical Engineering*, national AACE Treasurer, and author of a recent book, "Cost Engineering in the Process Industries". His talk was entitled "The Soaring or Souring Sixties".

Mr. Charles Keating of National Aniline will present a paper on "Pre-design Estimation of a Chemical Plant" at the April 10th meeting at the Boots and Saddle Restaurant.

NORTHEAST OHIO SECTION

The first meeting of the 1960-61 season was called to order by President Milton Wakefield at the Cleveland Engineering and Scientific Center on October 6th following a dinner meeting. Twenty-two members and guests were present.

Mr. Huttenlocher, Program Chairman, outlined the tentative program for the coming meetings:

November meeting: Address by Dr. Bernard Gaffney, National President, AACE entitled: "Cost Engineering and How Our Association Can Further its Aims".

December meeting: Workshop on "Cost Engineering Terminology"—Mr. William Funk, Chairman.

March meeting: Address by Mr. J. W. Hackney, former National President, AACE.

April meeting: Workshop on "Costs of Pressure Vessels"—Mr. Frank Flocke, Chairman.

May meeting: Address by Mr. William J. Hegerty entitled: "Cost Estimating and Control".

Mr. Ted Dorn, Membership Chairman, discussed the situation and prospects with respect to membership in the section and association.

Mr. Milton Wakefield described a recent meeting of the Cleveland Technical Society Council, at which arrangements were initiated for a television program aimed at increasing public familiarity with the engineering profession.

The speaker of the evening was Mr. R. F. Hitti, Supervisor of Technical Applications, Computer Department, Standard Oil Company of Ohio. Mr. Hitti's topic was "Computers and Their Use in Solving Technical Problems". He discussed ways in which the use of computers in an engineering organization can contribute to engineering production. Mr. Hitti emphasized their potency as well as their limitations as tools and described numerous steps in their programming and use. There was an active question and answer session following Mr. Hitti's very interesting remarks.

The November 3rd meeting of the Section was called to order by President Milton Wakefield. There were 27 members and guests present. The treasurer reported cash on hand in the amount of $144.26.

Mr. Harvey Huttenlocher, Program Chairman, again reviewed the programs scheduled for the coming meetings. He then introduced the speaker of the evening, Dr. Bernard J. Gaffney, National President of the AACE, and Director of Engineering, Wood Conversion Company, St. Paul, Minnesota.

Dr. Gaffney gave a most informative and interesting talk outlining the objectives of the cost engineering profession and of the National Association, and describing many of the past, present and future activities of the Association. He discussed highlights of the national convention in Houston and announced that next year's convention will be held in Boston and in succeeding years in New York City and Chicago.

Dr. Gaffney described the role of the cost engineer as the work of "engineers who attempt to set their companies' programs right, cost-wise". Logically, he said, the scope of their work includes the fields of cost estimating, cost control and profitability analysis. The scope of cost engineering extends equally into plant construction and into plant operations. Among their many functions in an engineering program, cost engineers must be able to understand and accommodate the objectives of both engineers and cost accountants. The Association is trying to develop a "language understood by all" in these fields — that is, to fill the needs for definitions of terms, establishment of standard nomenclature and of

standards for each preparation of cost estimates and cost reports, and development of constantly improving cost indices. The National Association has two main functions, said Dr. Gaffney: (1) technical development of the content of cost engineering, and (2) education and promotion. He commented on the evidence that in the field of accountancy numerous developments are underway nationally to improve the quality of usefulness of cost reports to management and suggested that cost engineers have an equal opportunity to improve the usefulness of reports on construction costs which are prepared for management.

Mr. John W. Hackney will speak on "Control of Capital Ventures for Process Industries" at the March 2nd meeting.

PITTSBURGH SECTION

On January 11th the Pittsburgh Section held a business and technical meeting at the Koppers Building. Prior to the meeting, a social hour and dinner were held at the Cork and Bottle Restaurant with a number of guests participating.

President C. E. Center convened the business meeting and announced nominations for section officers for the 1961-62 year. National director Addison Seekins announced preliminary plans for the forthcoming annual meeting. Five amendments to the By-laws were read by the secretary and are now to be submitted to the membership for vote by mail.

Vice President J. F. Rigatti announced plans for the March meeting with a tentative topic of computer applications to Cost Engineering. He then introduced the speaker, Mr. William F. O'Neil of the H. P. Foley Company, who presented an excellent talk entitled "Machinery Installation Costs". Mr. O'Neil emphasized the importance of good estimates if contracting organizations are to be profitable. He stated that savings in engineering planning prior to bidding usually result in excessive costs when the job is performed. A number of rules-of-thumb for rough estimating the costs of installing various classes of machinery were presented and discussed. A spirited question and answer period followed Mr. O'Neil's talk.

SOUTHERN CALIFORNIA SECTION

The Southern California Section held its second organizational meeting on November 11th with 37 persons present. They completed their organizational plans, adopted a set of By-laws, and set up a tentative program for a January meeting.

A January 19th meeting was held at the Engineer's Club at the Biltmore Hotel. Mr. M. C. Frishberg from the Data Process Division of IBM spoke to the group on "Least Cost Estimating and Scheduling".

SAN FRANCISCO SECTION

The San Francisco Section's Carmel Winter Workshop held December 10 and 11 at Del Monte Lodge, Pebble Beach, Carmel, California, proved to be a very interesting meeting. In addition to a stimulating technical program, such activities as golf matches, a sightseeing tour through the U. S. Naval Post Graduate School, and a theatre party and dinner dance were provided to entertain members attending the winter workshop.

A copy of the workshop program follows:

Workshops

Building Cost Estimating

Estimating Process Plants from Capacity Cost Curves

Cash Flow vs. Current Net Worth Approach to Capital Investment Analysis

Methods of Estimating Overheads and Indirect Construction Costs on Direct Labor and Material

Process Pipe Estimating

Forms and Check Lists Used in Estimating

Methods of Handling Depreciation and Their Effects on Taxes and Profits

Estimating Electrical

Direct Project Costs and Overheads — Which is it?

Background Requirements for Cost Estimating

A quarterly dinner meeting of the San Francisco Section was held at the Pot Luck Restaurant in Berkeley, California on January 25th with 30 people in attendance.

Announcement of the following officers for the year 1961 was made:

President:	A.L. Horstmeyer Wm. Horstmeyer Company
Vice-President:	Gus A. Anderson Kaiser Engineers
Secretary:	James G. Hoyt General Electric Company
Treasurer:	William E. Hand Shell Development Company

Speaker of the evening was Dr. Oswald Nielsen, Professor at Stanford University, who talked on "Cash Flow Analysis for Capital Investment Selection'.

What's Happening . . .

M. Robert Ackelsberg is now Manager of New Product Development for the W.R. Grace and Company's Polymer Chemicals Division. His previous position was that of Economic Evaluations Manager with the same company.

Donald G. Adkins has been promoted from Operations Manager to Vice President of E. L. Walker, Inc., Contractor-Engineer in Pensacola, Florida.

Felix M. Ales, who was previously a Structural Engineer with Foster Wheeler Corporation, New York City, has accepted a new position as Project Estimator for the Chemical Construction of the same city.

Lloyd B. Andrew, Jr. is presently Head of Economic Evaluation in the Research and Development Department of the Ethyl Corporation, Baton Rouge, Louisiana. He was formerly Director of Economic Research for Ethyl in New York City.

Russell W. Apolant has been appointed Assistant Secretary of The Lummus Company of New York City in addition to his duties as Manager of Contract Administration.

William R. Ashley, Jr. was recently promoted from Estimator to Supervisor of Estimating for Atlas Powder Company, Wilmington, Delaware.

Franklin A. Bassett, former Engineer-Estimator for diamond Alkali Company, Cleveland, Ohio, is now Construction Engineer with The Lummus Company of Newark, New Jersey.

Jonas M. Berk has announced the formation of a new partnership in the consulting engineering business. He and three other industrial appraisal engineers have opened their offices in Houston, Texas.

Gilbert E. Burress, who was previously Cost Engineer with the Southern Engineering and Construction Company of long Beach, California, is now holding the same position with Paul Hardeman, Incorporated of Stanton, California.

Matthew F. Callahan is now Sales Engineer in the Plastics and Resin Department of Allied Chemical Company, New York City. He was formerly Chemical Salesman with the same company in Toledo, Ohio.

Edward J. Cambell, previously Group Leader — Special Projects in the Industrial Engineering Department of the Whirlpool Corporation of St. Joseph, Michigan, is presently Manager of Industrial Engineering, Manufacturing Engineering Department of the same corporation.

Thomas Charles, formerly Senior Estimator for the Catalytic Construction Company in Philadelphia, Pennsylvania, has been promoted to Director of Purchases of that company.

John B. Charlton has moved from Pensacola, Florida branch of the Chemstrand Corporation to the Decatur, Alabama branch.

Donald S. Cheney has accepted a new position as Senior Civil Engineer, Dewline Operations with the Federal Electric Corporation of Paramus, New Jersey. He was previously affiliated with Goldstone and Dearborn, Architects, New York City.

Charles A. Coghlan is now Senior Technologist in the Beacon, New York laboratories of Texaco, Incorporated. His former position was Head, Process Engineering Research Section for the Texas U. S. Chemical Company located in Port Neches, Texas.

Aaron J. Cohen, Consulting Engineer of Houston, Texas, has just completed a comprehensive report on the economic justification of rebuilding valves through the use of solid film lubrication and protective coatings. This report is the culmination of five years of intensive field research plus the establishment of a qualified organization specifically equiped to rebuild valves for the petroleum, marine and process industries. Mr. Cohen is making copies of this report available to AACE members specifically interested in the cost of maintaining valves in those related industries, and the report will soon be listed under available technical papers.

Robert F. Dennee, formerly Material and Cost Statistical Analyst in the Design Engineering Department of The M. W. Kellogg Company, New York City, is now Section Head — Systems Development in the Administrative Engineering Department of the same company.

Joel H. Hirsch is presently Director of the Development Engineering Division of the Gulf Research and Development Company in Pittsburgh, Pennsylvania. His previous position was Chief Development Engineer for the same company.

Gerard W. Hirschhorn, former Product Engineer in the Research and Development Department of the Wood Conversion Company, St. Paul, Minnesota, is now Manager of Marketing Research in the Sales Department of the same company.

William R. Kelley has been promoted from Value Engineer to Program Planning Engineer with the General Electric Company located in Johnson City, New York.

Thomas J. Kent, Jr., with Kellogg International Corporation in London, England, has been moved to a new position as Special Assistant to the Vice President of Contract Operations. His former position was that of Manager of Operations Control in the Operations Administration Department of Kellogg International.

Carl Labovitz is now Project Engineer for The Rust Engineering Company in Pittsburgh, Pennsylvania. He was formerly Vice President of Chempro, Incorporated in the same city.

Gregory M. Reinhart, who was previously Section Leader in the Chemical Department of the National Lead Company of Cincinnati, Ohio, is presently Engineer in the Process Department of a branch of the same company located in St. Louis, Missouri.

Tom C. Rhodes, former Cost Engineer for Dow Chemical Company, Freeport, Texas, is now Senior Estimator for the same company.

Thomas J. Roche had an article entitled "Urban Factors that Boost Construction Costs" published in the January, 1961 issue of *Roads and Streets.*

Gonzalo Arthuro Rojas, who has been with Koppers company, Inc. in Pittsburgh, Pennsylvania on a one-year indoctrination program, has returned to work in Chile with Koppers Chilean affiliate, Sigdo-Koppers S. A.

Orrin J. Stransky has been promoted from Cost Engineer to Director of Cost Engineering for the Stearns-Roger Manufacturing Company, Colorado.

Frederick T. Weyerhaeuser, former Industrial Engineer in the Central Engineering Department of Wood Conversion Company, Cloquet, Minnesota, is now Supervisor of Cost Control and Planning in the Production Department of the same company.

Kenneth G. Wolfe has been promoted from Assistant Chief Estimator to Chief Estimator with Bechtel Corporation in San Francisco, California.

Message from the President

(Continued from page 3)

Our Regional Sections have done a great job in stimulating local interest in the Association, which has resulted in increased membership. With the recent approval of the Board we now have two more — Niagara Frontier and Southern California Regional Sections. We congratulate the members from these new Sections and wish them success in their activities. Other members are actively working towards creation of local sections in Detroit, Toronto, Montreal, Cincinnati, Minneapolis, St. Paul, and London, England. We look for big things from all of these new areas, to match results of our older Sections; the opportunitnes for all are tremendous!

We are asking our publicity committees at both the national and regional levels to increase their efforts to carry the Cost Engineering story to the public.

Our application for membership in the Engineer's Joint Council has been approved for submission to EJC this spring. Our acceptance will provide us with important professional recognition.

Due to the resignation of Jim Caulfield from the Board of Directors, Don Meikle was appointed by the Board to fill the unexpired portion of his term of office. Don was the spark-plug in establishing the Chicago-Midwest Regional Section, and we expect big things of him as Director-Sponsor of the Member Relations Committees.

This year's annual meeting is offering a technical program which no member can afford to miss! With the emphasis this year being placed on seminar type meetings, you will have more opportunity for discussion with each speaker, to gain the maximum understanding of the subject matter. The New England Section and the Somerset Hotel are making every possible effort to assure an efficient, entertaining and comfortable convention this year. I hope you will all be able to attend.

This year will not be an easy one for the United States in foreign relations, or in the national economy; and it will not be an easy one for us in Cost Engineering. Wishing for it, or asking for it, will not be the answer. In the final analysis, our success will depend upon the professional pride and perseverance of our individual members. Just remember, the good Lord feeds the little birds, but he doesn't throw it into the nest!

James Bachman, who has been "spark-plugging" the Montreal Section, has returned to Stanford University in California to work toward a Master's Degree in Industrial Engineering.

Donald F. Brosnan, who was formerly with Foster Wheeler Corporation in New York City, is now Senior Estimating Engineer in the Estimating Department of Bechtel Corporation located in the same city.

Personnel Service

With the objective of increasing the services to our members, the *Bulletin* includes a Personnel Section.

Members will be permitted two free insertions in the "Men Available" section per year.

There will be a charge for insertions in the "Positions Available" section. Write to the Editor, AACE *Bulletin* for additional information.

MEN AND POSITIONS AVAILABLE

Cost Engineer — Member AACE, degree in architectural engineering; especially experienced in building evaluations, surveys and cost estimates; at present available for part time assignments or on free lance basis; excellent references: William Zirkel, 936 Hinman Avenue, Evanston, Illinois.

Cost Engineer — Member AACE, degrees in engineering and accounting; 12 years excellent experience chemical and petrochemical plant estimating, cost control, cost analysis, and engineering economic evaluation; available immediately; excellent references: F. A. Bassett, 287 Dogwood Lane, Mentor, Ohio.

Cost Engineer — Member AACE with 15 years experience in estimating and cost analysis of all types of construction. Skilled at devising estimating techniques with minimum information for budgets and proposals. In present position for four years. Seeking position as Estimating or Cost Engineering Manager. Prefer Northern California. Write: Reference G, American Association of Cost Engineers, Durham, New Hampshire.

Technical Papers

Available free, AS LONG AS THEY LAST, to AACE members ($.50 to nonmembers), by request:

1 — "Accurate Ways to Estimate Pipe Costs" by W. G. Clark

2 — "Computer Speeds Economic Evaluations" by J. F. Adams, W. L. Massey, Jr. and M. Dmytryszyn

5 — "Ratio Cost Engineering" by H. C. Bauman

6 — "The Cost of Preparing an Estimate" by K. G. Wolfe

7 — "Which Depreciation Method is Best" by B. J. Gaffney

18 — "Estimate Cost of Compression Plants" by I. Bromberg

20 — "Estimate Cost of Fractionation Systems" by I. Bromberg

21 — "Educational Requirements from the Standpoint of Industry for Future Engineering Graduates" by D. I. Meikle

22 — "Project Evaluation by the Time Value of its Use of Money" by E. H. Flewellen, Jr.

23 — "The Case for Scientific Research in Cost Engineering" by L. R. Shaffer

24 — "A Course in Chemical Engineering Economics" by J. Happel

25 — "Cost Control in Construction" by W. McGlaun

26 — "Project Cost Control" by W. G. Clark

27 — "Economic Evaluation of Research Projects" by R. C. Brown

30 — "Measuring and Controlling Maintenance Costs" by Raymond I. Reul

31 — "Essentials of Cost Control for Capital Plant Expenditures" by Cost Control Committee, Metropolitan New York Regional Section

37 — "Determination of Present Worth of Industrial Plants for Ad Valorem Tax Purposes" by C. E. Lunsford

39 — "Determination of Optimum Plant Size" by H. C. Thorne, Jr.

40 — "Bibliography of Investment and Operating Costs for Chemical and Petroleum Plants, January — December, 1959" (Bureau of Mines Information Circular 7966) by Sidney Katell, John H. Faber, John W. Douglas
(A copy of technical paper No. 40 was sent to all AACE members.)

The Association is endeavoring to publish in the *Bulletin* or make available reprints of papers that are related to the field of Cost Engineering. If you are preparing a paper or have presented previous papers in this field please send a copy to the Editor so that it can be included in future surveys of data in this area.

In Passing

(Continued from page 4)

of the committee will be a welcome addition to the cost index manual and will be of such a nature as to reflect a very thorough analysis of the subject and provide means for timely application of current and historical indexes. It is also anticipated that the committee will work with the various publishers of indexes, including government sources, and will cooperatively forward the aims of the AACE in this respect.

The day following the board meeting I was graciously hosted at the New York Regional Section's Meeting in the Advertising Club in New York City. In a very short talk I outlined different line and staff functions existent within our association and the kind of results that are expected from these functionary groups.

Earlier this year it was decided to prepare an organizational manual which would specifically outline lines of communication and responsibility of our various officers, directors and committeemen on both a parent association level and that of the regional level. The effort bogged down after a good start and needs to be revived. It is not an easy job, but once done, it will pay dividends. To sensibly operate we need such a guide. We need to know our lines of communication. We need to know what prerogatives may be taken in a number of circumstances. When an organization is small, much can be done in an informal manner. As it grows it becomes important that the organization be summarized in order to achieve specified results and many of them in accordance with fixed time schedules. The committee that is working on this organizational problem will be reactivated and our recent board meeting has set the ball rolling again.

This year I hope that a good precedent has been set. That precedent relates to having officers of the parent association attend regional meetings whenever possible and to visit with regional officers. From the meetings I have been able to attend I can assure the membership that we have a very fine organization, and it has certainly been my pleasure to work with you.

As the year closes one can look on noted accomplishments — several new regional sections in the making and in effect, including our British Group; a profitable Houston meeting; application to EJC; a sound financial position; several papers published by members; some splendid regional meetings and activities; and a growing membership of over 850.

Regional Section Directory

If you reside near one of the regional sections, contact the secretary so that you can benefit from the worthwhile activities of your region. If a business trip coincides with a meeting of a section outside your region, you are welcome to participate in any and all activities.

CHICAGO — MIDWEST

Chairman — Warren W. Twaddle, Amoco Chemicals Corp., 130 East Randolf Street, Chicago 1, Illinois.
Secretary — Daniel T. Brink, Corn Products Co., 201 North Wells, Chicago 6, Illinois.

DELAWARE VALLEY

President — John J. Farrell, Catalytic Construction Co., 1528 Walnut St., Philadelphia 2, Pennsylvania.
Secretary — Leslie C. Jenckes, Sun Oil Co., 1608 Walnut St., Philadelphia, Pennsylvania.

GULF COAST

President — Ray Hopkins, Monsanto Chemical Co., Box 1311, Texas City, Texas.
Secretary — Duncan G. Allen, Allied Appraisal Co., 5901 Beechnut St., Houston 36, Texas.

METROPOLITAN NEW YORK

Chairman — Cecil H. Chilton, *Chemical Engineering*, McGraw-Hill Publishing Co., 330 West 42nd St., New York 36, New York.
Secretary — Kenneth M. Guthrie, The M. W. Kellogg Co., 711 Third Avenue, New York 17, New York.

NEW ENGLAND

President — Walter H. Langhoff, Metcalf and Eddy, 1300 Statler Bldg., Boston 16, Massachusetts.
Secretary — Philip E. Johnson, Lawson Machine and Tool Co., 120 Mountain Ave., Malden 48, Massachusetts.

NIAGARA FRONTIER

President — Richard G. Hopper, Uhl, Hall and Rich, P.O. Box 327, Niagara Falls, New York.
Secretary — Allen G. Smith, Jr., Uhl, Hall and Rich, P.O. Box 327, Niagara Falls, New York.

NORTHEAST OHIO

President — Milton C. Wakefield, Harshaw Chemical Co., 1945 E. 97th St., Cleveland 6, Ohio.
Secretary — Vernon C. Squires, Goodyear Tire and Rubber Co., c/o Dept. 110D, 1144E. Market St., Akron, Ohio.

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